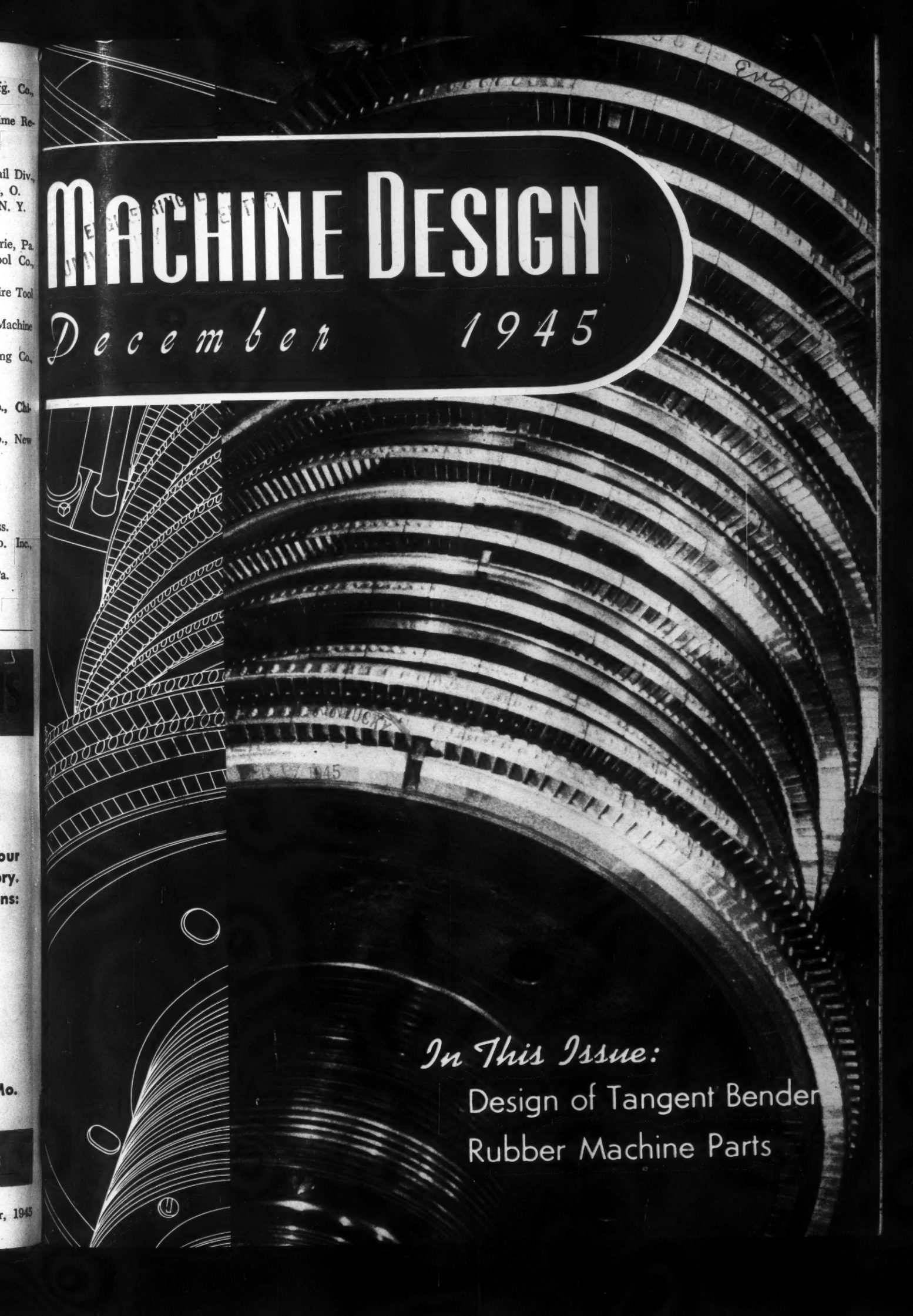
MACHINE DESIGN
December 1945
In This Issue:
Design of Tangent Bender
Rubber Machine Parts

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Published by The Penton Publishing Co. E. L. Shaner, Pres. and Treas.; G. O. Hays, Vice Pres. and Gen. Mgr.; R. C. Jaenke, Vice Pres.; F. G. Steinebach, Vice Pres. and Secy.; E. L. Werner, Asst. Treas. Published on seventh of month.

Subscription in U.S. and possessions, Canada, Cuba, Mexico, Central and South America: Two years, $10; one year, $6. Single copies, 50 cents. Other countries: Two years, $14; one year, $8.

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MACHINE DESIGN

How Tangent Bender Tucks Flange Metal

By L. B. Green
Consulting Engineer
Struthers Wells Corp.

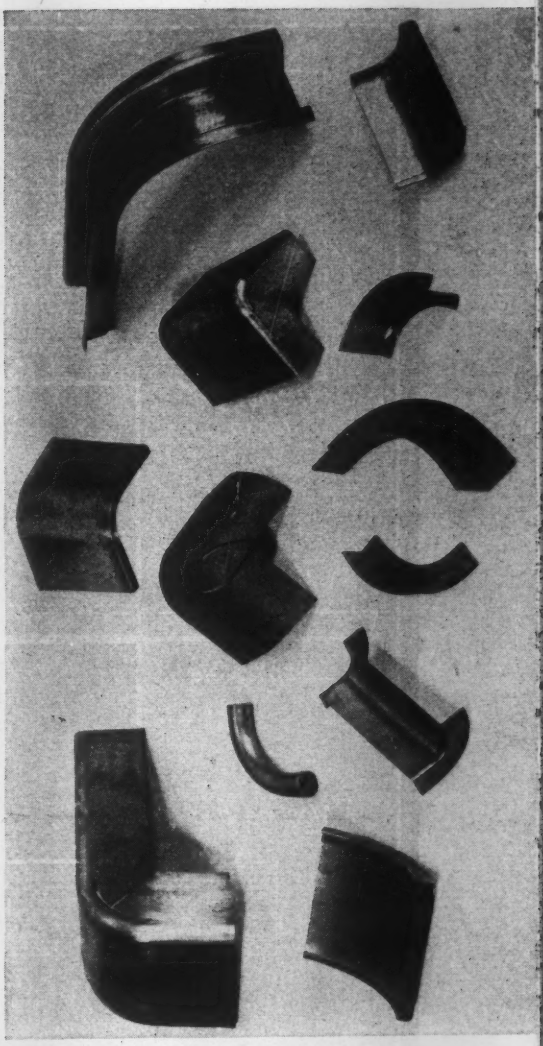


Fig. 1 — Above — Representative flanged shapes that may be formed successfully on bender

TANGENT bending machines were first designed to achieve economical production of modern refrigerator shells. After these machines were built, however, many other applications have

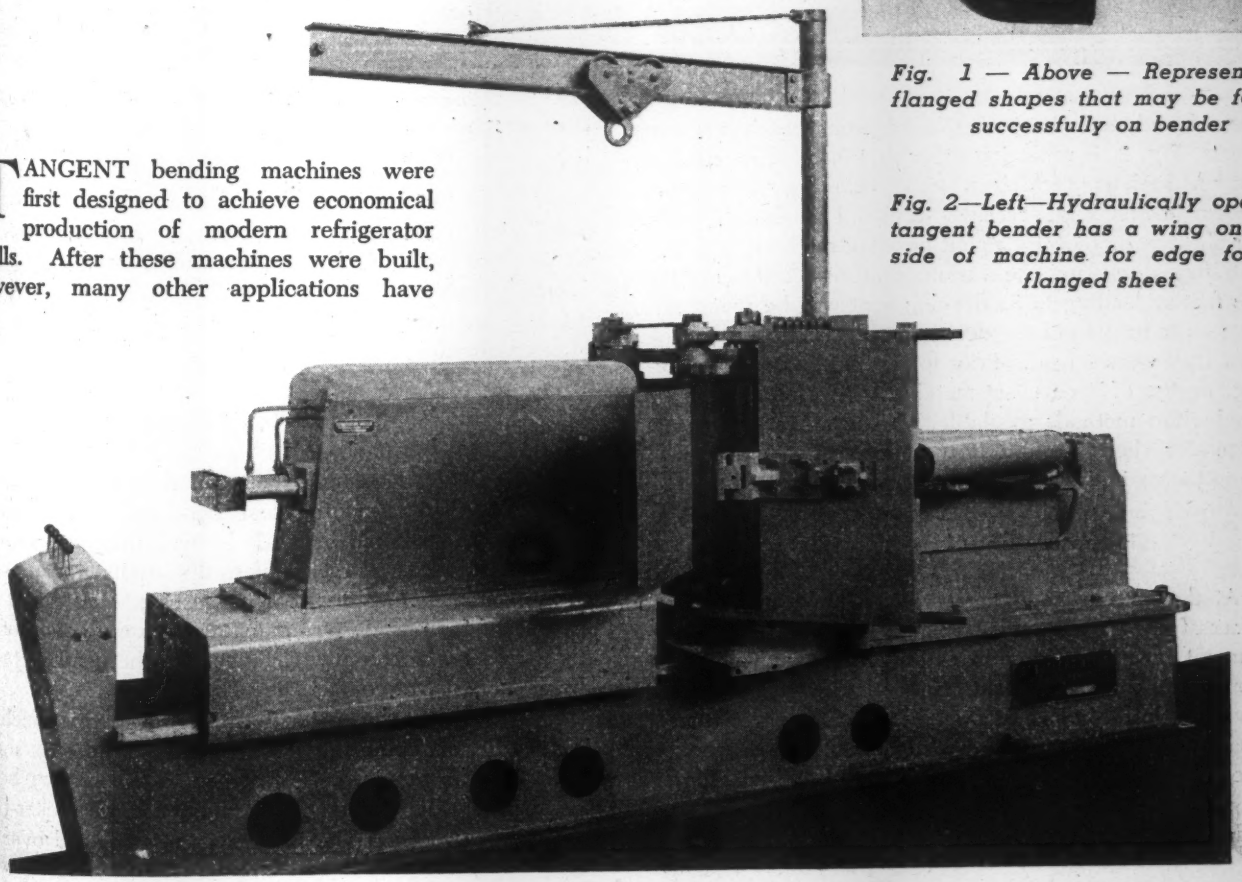


Fig. 2—Left—Hydraulically operated tangent bender has a wing on each side of machine for edge forming flanged sheet

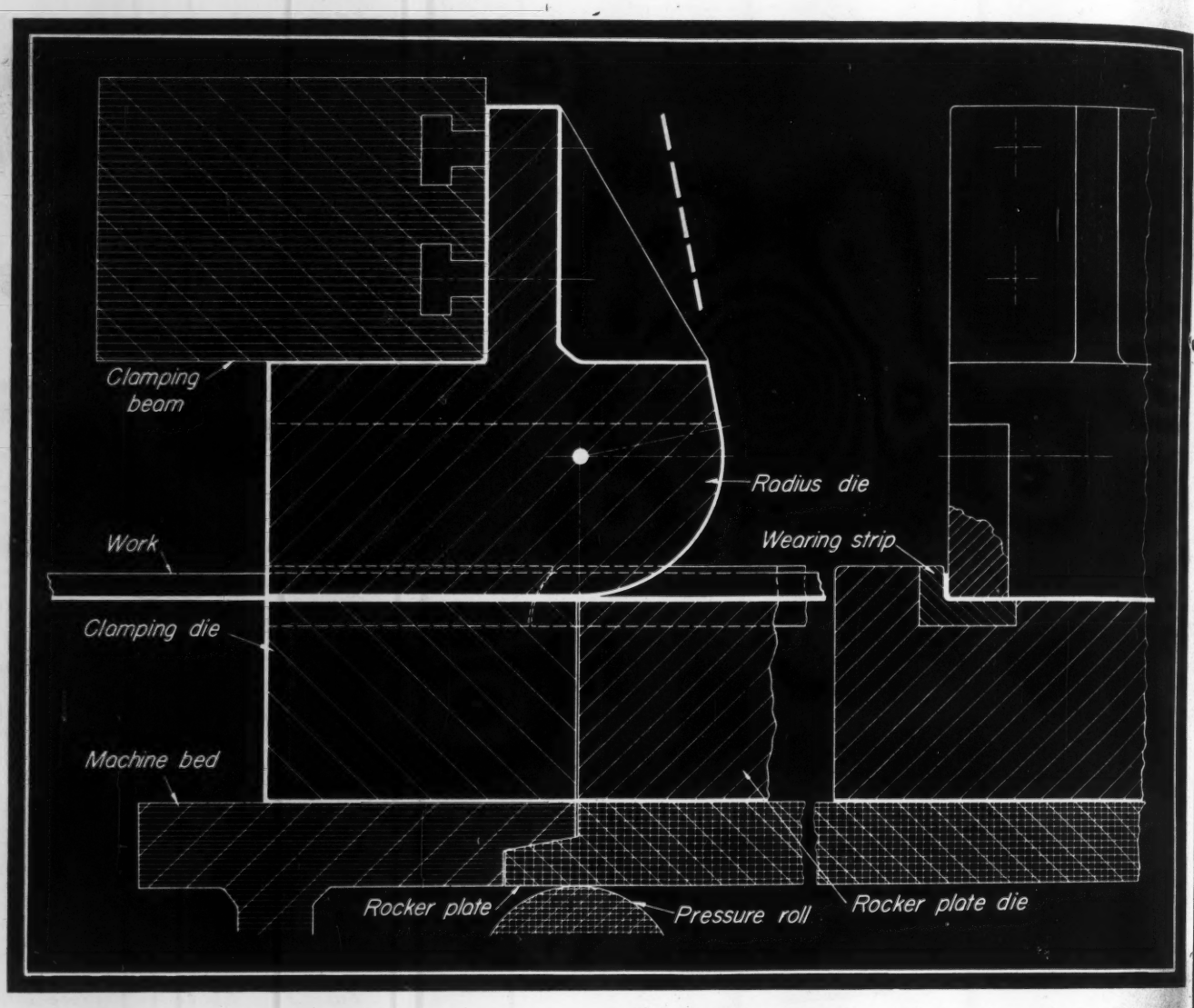


Fig. 3—Principle utilized in forming. Flanged sheet is bent around radius die closely confined between the radius die and a rocker-plate die

been found and the principle of edge bending flanged sheets, *Fig.* 1, is replacing other methods, eliminating operations such as notching, welding, grinding and polishing. Shown in *Fig.* 2 is a recently designed machine for forming sheet parts by the tangent bending method.

Before discussing the various features of this machine, the factors leading to its development will be reviewed to give an indication of the design problems encountered and how they were solved. Prior to this method of edge forming, design of such sheet-metal parts was limited by the production methods available. To produce the style refrigerator shells desired it was necessary to use two or more pieces individually formed and joined.

Increases Cross Section of Flange

At the present time there are two methods being used successfully to edge bend metals—stretch bending and tangent bending. Stretch bending reduces the cross section of the part somewhat or in other words takes metal away to do the job. Tangent bending, however, tends to "pack" the metal in and by so doing increase the cross section, adding strength to the part. In a machine such as shown in *Fig.* 2, it is possible to form both the top and sides of a modern refrigerator shell from a single sheet of metal with rolled flanges. In the same operation the top corners are radius formed. Heretofore, it was necessary to notch such flanges before bending and finish by welding and grinding. This was costly and unsatisfactory for high-production work.

Rocker Plate Is Always Tangent to Bend

By confining the flanges between two die members, it was found that a smooth, clean bend for shapes such as shown in *Fig.* 1 could be made by wrapping one member known as the geared rocker-plate die around a radius die as illustrated in *Fig.* 3. It is interesting to note that this method of forming derives its name from the action of the rocker plate which is always tangent to the bend or radius die at the point of contact.

Three parts make up the forming die in this machine. Radius die, clamping die and rocker-plate die. As shown in *Fig.* 3, the radius die is fastened to a clamping beam, the clamping die to the machine bed, and the rocker-plate die to a rocker plate. A flanged sheet is placed over the

clamping die and the rocker-plate die with the radius die retracted to clear the work. After the sheet is placed in the dies the radius die beam is closed to clamping position, holding the work during the bending operation. *Fig.* 3 shows the dies clamped just before bending. A wearing strip on the rocker plate extends beyond the center at the start of the bend, overlapping the clamping die so as to protect the flange at this point and prevent wrinkling at the start of the bend.

The rocker plate is backed by a heavy, heat-treated steel pressure roll which is geared to the back face of the rocker plate to assure true alignment during movement of both members. In conjunction with the rocker plate the pressure roll is capable of handling the heaviest load within the capacity of the machine without noticeable deflection. Mounted in a swinging wing, the roll is free to travel with the movement of the rocker plate.

Box-Section Wing Provides Rigidity

Power arm of the tangent bending machine is the swinging wing assembly shown in *Fig.* 4. Box-section of welded steel construction is utilized for the wing frame or housing to give ample rigidity. The wing spans the main frame, hanging on large-diameter flanged trunnions. These members are assembled through the side frames from the inside and pulled up tight with socket-head screws. A clearance hole for a one-inch bolt is provided between the end thrust plate and the shoulder which extends through the main frame to allow very little end play of the wing when in place. Oilless bronze of a grade suitable for heavy loads is used on all wing bearings.

These wings are swung about a fixed axis directly over the radius of the work and are powered with a heavy-duty hydraulic cylinder capable of exerting a steady, smooth motion to the wings. This action is important for edge bending steel, brass or aluminum, allowing the metal to flow sufficiently for a smooth bend.

Allows for Overbend

Adjustments for limiting the movement of the wings are provided at the clevis mounting end of the cylinders so as to control the amount of overbend at the outward end of the stroke and allow for spring back in the part being formed. Provisions have been made in the hydraulic circuit to prevent either cylinder from moving in advance of the other. It is also arranged so that one cylinder can be locked back while a single bend is being made with the other.

Pressure is applied against the work through heavy springs pressing the roll against the rocker plate. The front face of the rocker plate rack is meshed with the radius gears which have a fixed relation to the radius of the bend. By gearing the back face of the rocker plate to the pressure roll and the front face to the radius gears, the rocker plate is held in perfect alignment and tangent to the bend at all times.

The radius gears are located in a fixed position on the machine frame with a pitch radius equal to that of the die for a full rocking bend. Rack members meshing with these gears are fixed to the top side or face of the rocker

Fig. 4—Construction of swinging wing. Rocker-plate racks are meshed with both a radius gear and a pressure-roll gear to control "tucking in" of the flange metal on the workpiece. Each wing is powered by separate pumps

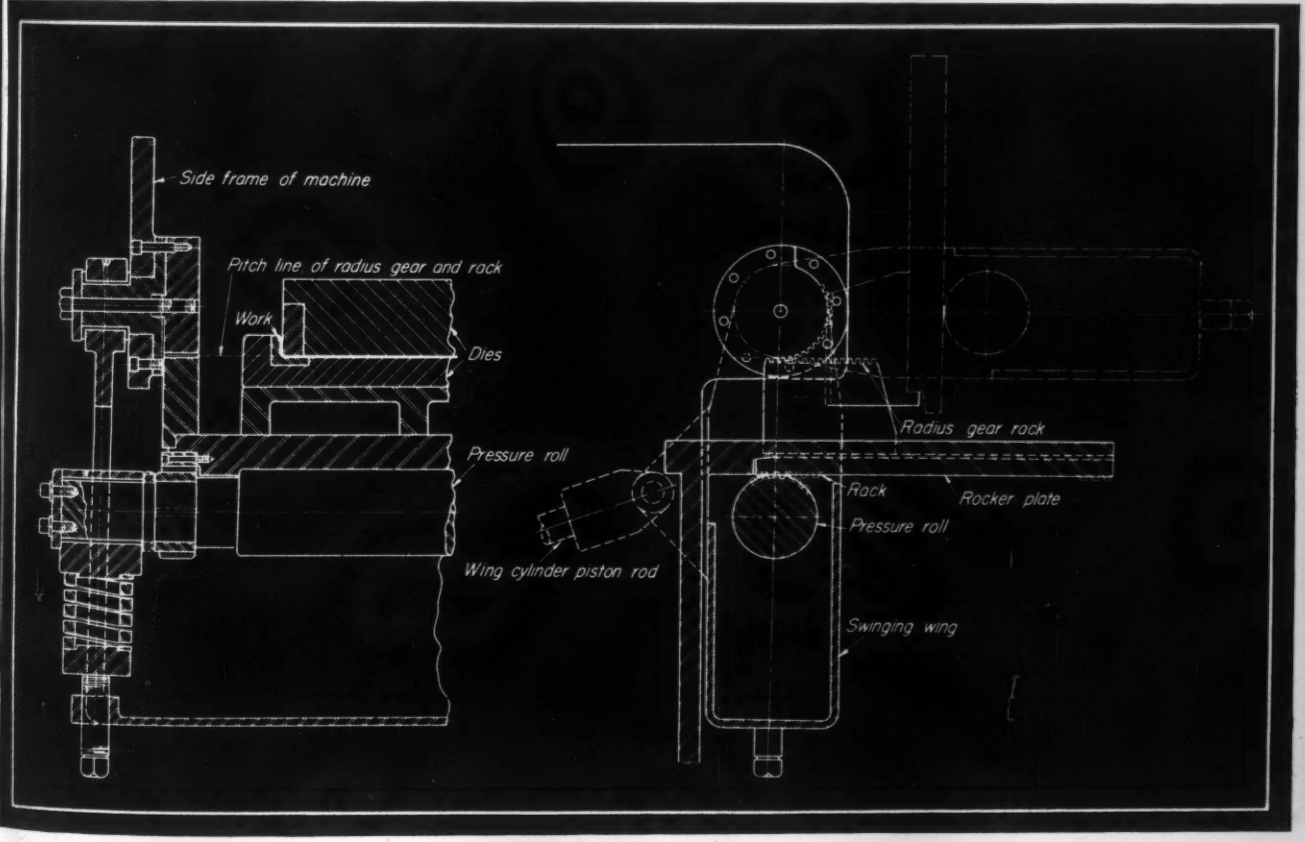


plate. The pressure roll has a gear keyed tightly at each end, meshing with a pair of racks, one located at each end on the under side of the rocker plate.

Amount of rocking can be controlled by employing slippage. Through gear and rack changes, movement from zero rock to over rock can be obtained. A slip plate may be inserted at any spot on the work which will take a full free rock, regardless of what is required on another part of the section. Work can be clamped to the rocker plate near the die and formed by stretch bending where necessary. A large radius can be formed with a small radius die by "inching". With work clamped in the usual manner, the wing can be swung a short distance out and back much the same as would be done in a press brake, except the radius die will blend the steps together to produce a reasonably accurate curve.

Carriage Swings To Remove Work

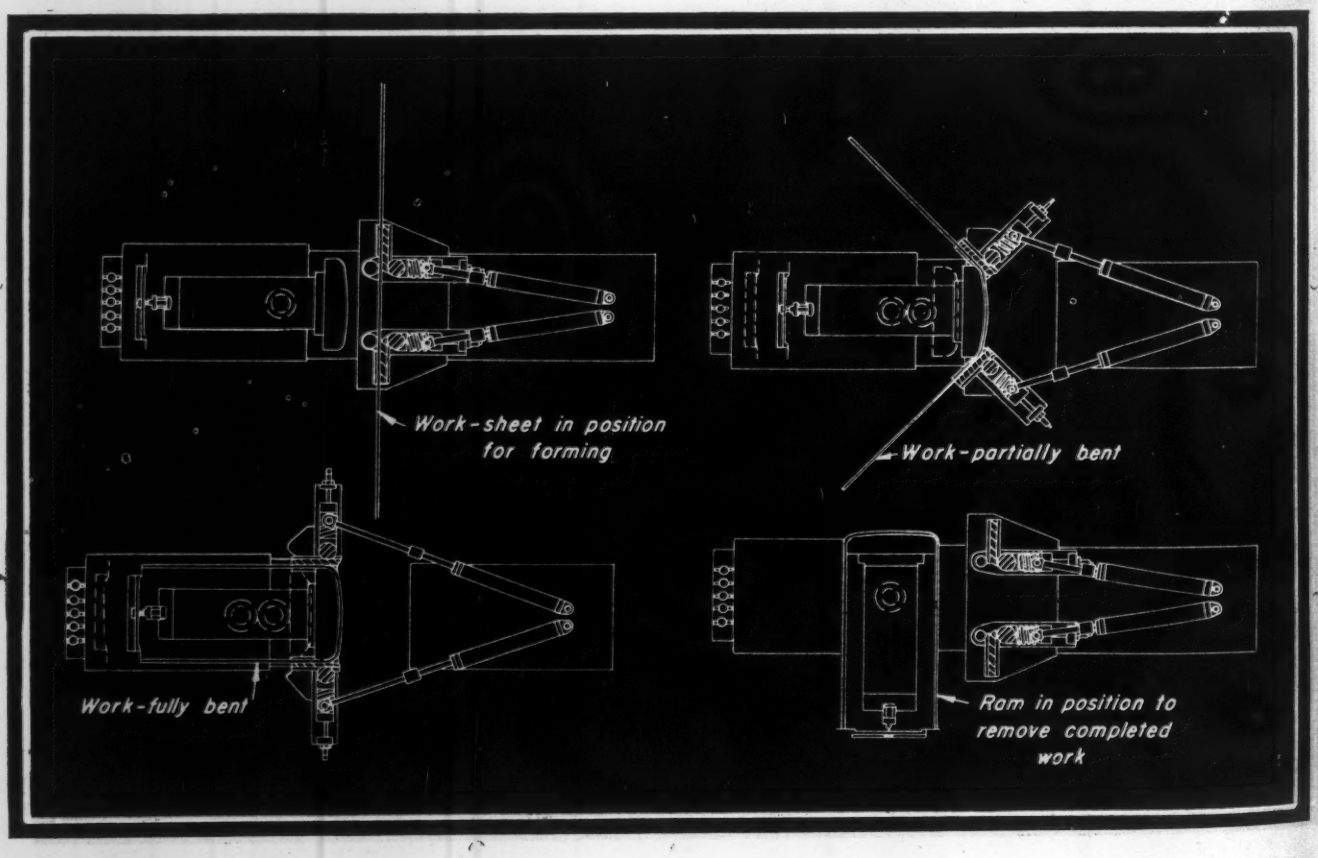
Clamping and forming motions of the machine are shown schematically in *Fig.* 5. The punch part or radius forming die is mounted on a swinging carriage of the main ram. This carriage is supported by an 8-inch diameter hollow spindle on the top face of the main ram and swings 90 degrees to the right or left side of the machine. The main ram is slidably mounted on the main frame of the machine and its movement to and from the clamping die is controlled by a heavy-duty hydraulic cylinder mounted between the ways of the main frame. A clamping pressure of 50 tons is exerted against the work to prevent its slipping during forming. To support the swinging carriage against this heavy load and to lessen the load on the spindle, a table wedge is provided at each end of the swing carriage. These members are part of the main carriage and radial in form to allow the carriage to turn when the pressure is relieved.

Reason for incorporating a swing carriage on the main ram is to make it possible to form long sheets. The 10-inch ram stroke to and from the work allows sufficient movement to clear the die and rotate the carriage for removal of the work. Otherwise it would be necessary to use a stroke sufficiently long to clear the sides of the formed sheet.

Forming Action Compared with Roll Forming

In *Fig.* 6, action that takes place while edge bending a flange is shown. Comparison is made with an edge bend produced by roll forming for the same height of flange. This illustration shows the path of a single point located on the die flange edge at the point of contact with the radius die. The curve in relation to the movement of the rocker plate shows that the metal is tucked back during all the movement, except for the last 15 degrees in a 90-degree bend. A roll die with its flange contacting the same point, traveling but 45 degrees, passes down and back over the flange and produces a chafing action on the metal which tends to crowd it away from the flange during rolling. In the sectional view at the right in *Fig.* 6, clearance is shown in the dies to allow for thickening at the edge of the flange.

Fig. 5—Schematic representation of forming operation showing radius die on main carriage which advances to clamp the work. Rocker plate dies on swinging wings form the sheet to the radius die. After retracting wings and main ram, carriage rotates to provide for removal of work



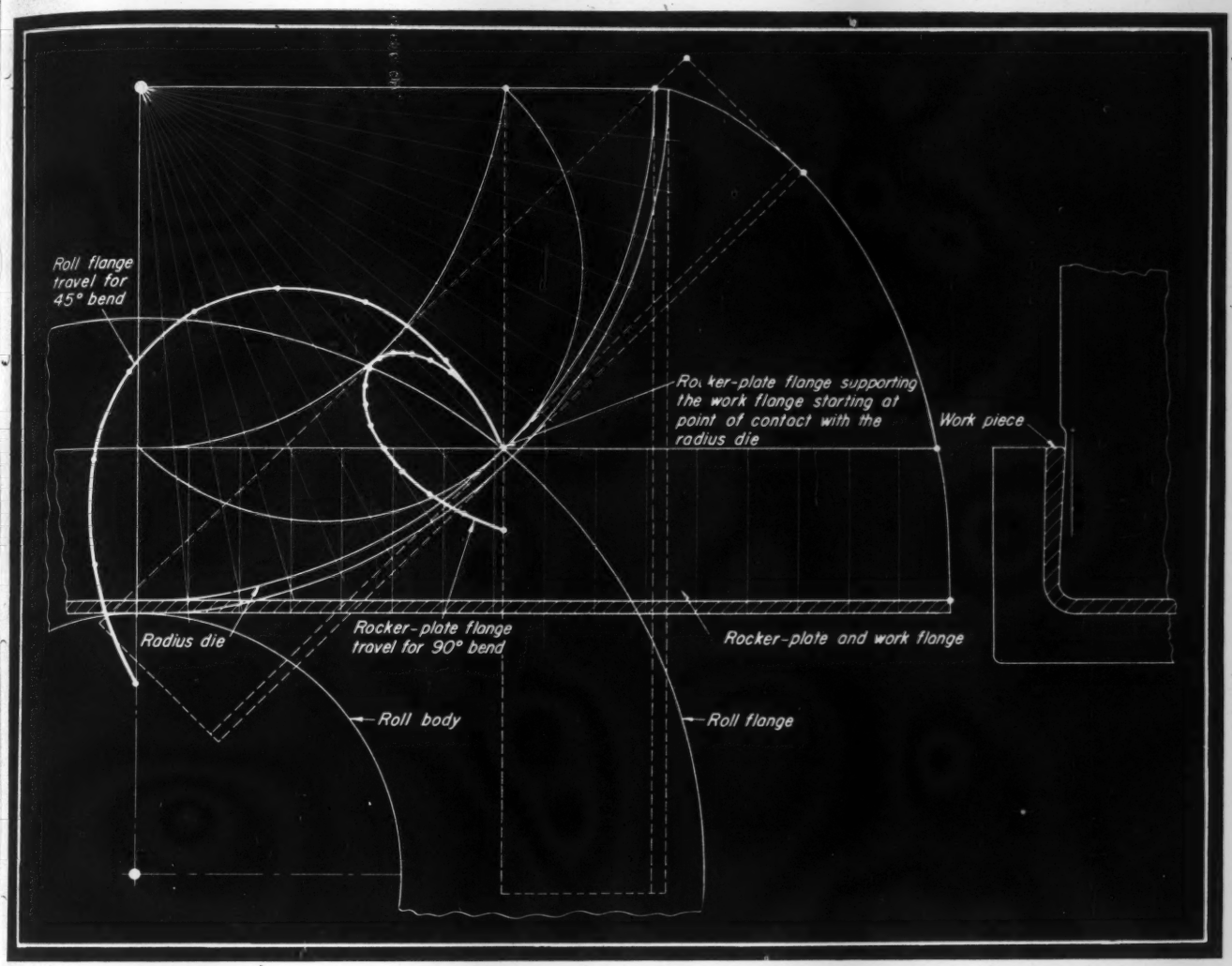
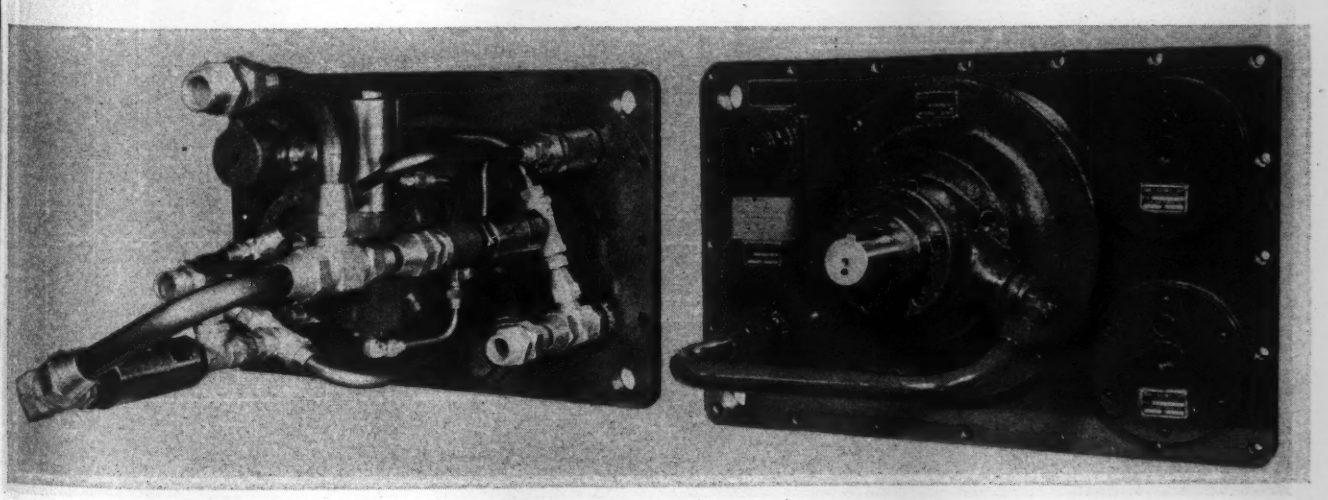


Fig. 6—Above—Action of dies for rocker-plate forming compared with roll forming. Loci of points for each method are shown, taking same point of contact of die flange with work at beginning of bend. Action of rocker-plate die remains almost within the workpiece flange for a 90-degree bend while that of a roll die wipes across the flange with a chafing motion and for the greater part of its travel is outside the flange for a 45-degree bend, using a roll with the radius shown

Fig. 7—Below—Hydraulic panel containing pumps and valves is a unit assembly for mounting in machine base

Earlier designs of this type of machine were operated pneumatically rather than hydraulically. Air operation worked well on gages heavier than 0.05-inch but was unsatisfactory on lighter gages with high flanges. Hydraulic power is now used on this machine for the following reasons: First, steady motion is of major importance. Second, high work holding pressures are essential. Merely locking the dies together by mechanical clamping means is not sufficient in most cases to hold the work from slip-



ping. Third, when the dies are designed to crown or dome the work, the ram must hold firmly and stretch the metal to the desired shape. Fourth, adequate air supply is not usually available to maintain a production machine of this kind. Fifth, the hydraulic circuit is of the closed type, eliminating all exhaust noise which was found objectionable when air was used for power.

Power Is Supplied from Triple Pump

Incorporating hydraulic cylinders to control the movements of the swinging vane which replaced the cross head and connecting rods used in the earlier designs made it possible to provide ample back support for the dies. Without this support it was found that under heavy bending loads the dies showed a tendency to spring apart, leaving the upper flanged sections of the work without sufficient clamping pressure. This member also supports a six-foot span swinging crane for handling the dies to and from the machine.

Hydraulic power is supplied from a unit assembly, *Fig.* 7, which also incorporates control valves. Designed and engineered by the John S. Barnes Corp. to be an integral part of the machine, the schematic circuit in *Fig.* 8 shows how the panel controls the movements of the main ram, swing carriage and swinging wings.

Driven by a 10-horsepower motor, a triple pump is incorporated in the assembly. The duplex roto-blade vane pump supplies the large-volume, low-pressure fluid for rapid traverse. The high-pressure piston pump supplies a small volume of fluid at high pressure for piercing and holding. This circuit makes use of a unique arrangement of the two rotary pumps. They may operate in parallel as a duplex circuit or may operate jointly as a single circuit. On the main ram cylinder the two rotary pumps join their fluid and supply a large volume for rapid traverse. In the wing cylinder circuit they deliver their fluid individually to two independent circuits.

Finger-tip Control Simplifies Operation

In operating sequence the hydraulic circuit functions as follows: With work loaded in the dies, the main ram is brought forward at fast traverse. When the work is contacted the automatic two-volume circuit shifts from rapid traverse to the slow or high-pressure traverse. If piercing is required it is accomplished at this stage, and the work is held within the dies with a force of 50,000 pounds. The wing cylinders are then brought forward either individually or simultaneously. After return of the wing cylinders and ram cylinder the carriage cylinder is operated, revolving the carriage 90 degrees and presenting the formed workpiece for unloading. The complete sequence is under finger-tip control of the operator as all valves are electrically operated from a main control panel.

Within the capacity of the 50,000-pound ram the machine is capable of handling straight stamping work such as blanking, piercing, embossing and shallow draws, also press brake bending. The entire machine is of welded construction and all fabricated assemblies are stress relieved at 1250 F for twenty hours before machining.

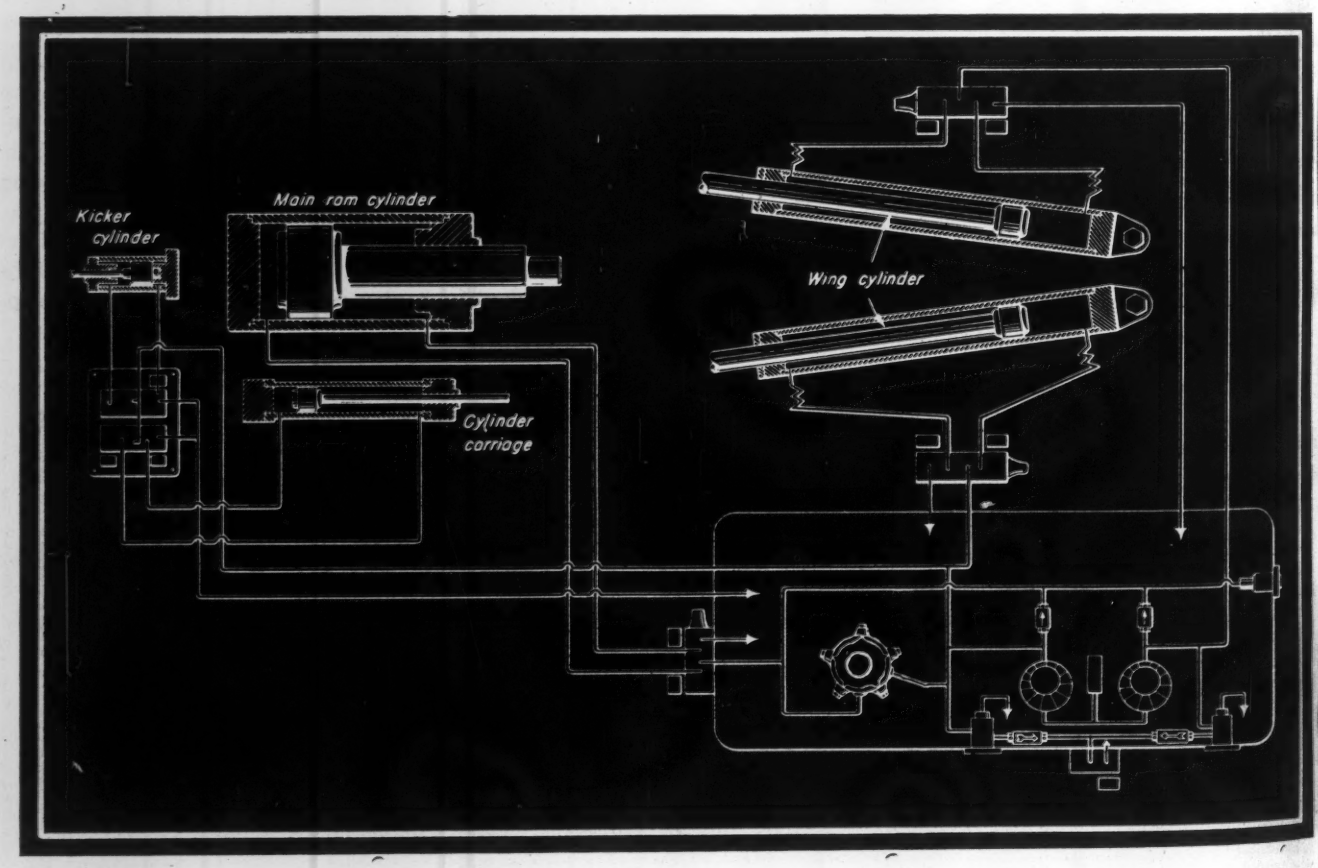
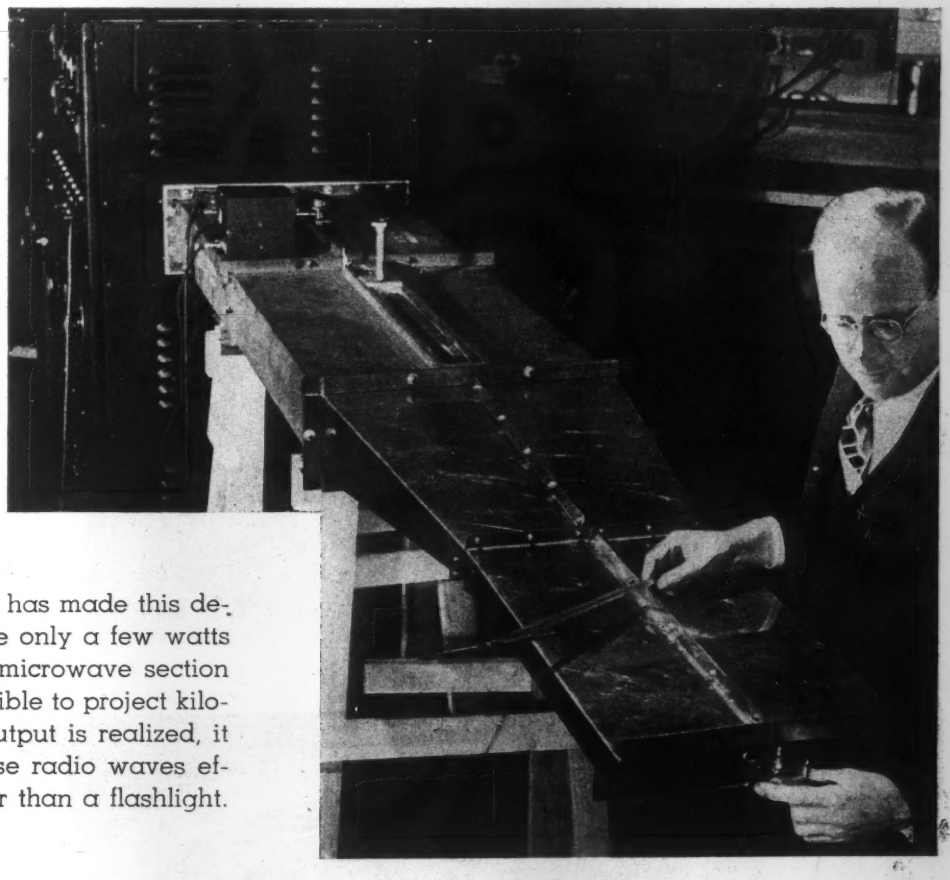


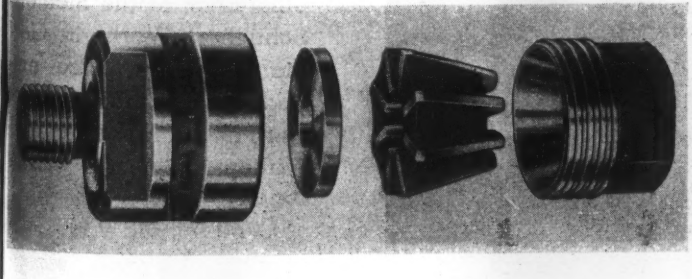
Fig. 8—Hydraulic circuit showing how pilot-controlled power unit actuates pistons for machine operation. Rotary pumps operate either individually for each wing or together to supply large volume of fluid for main ram. Piston pump boosts pressure on main ram to 50,000 pounds

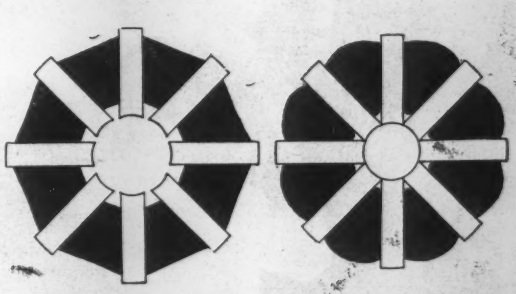
Scanning THE FIELD for Ideas

Ultrashort waves are being used experimentally at Westinghouse Research Laboratories for heating by projecting the waves on the material to be heated as shown at right. Previous devices required that the object be placed in an electrical field created between two electrodes. Projected waves, however, can be used in restricted areas and can be utilized for irregularly-shaped objects. Wartime accomplishment of bringing horsepower to microwaves has made this development possible. Heretofore only a few watts at most could be used in the microwave section of the spectrum. Now it is possible to project kilowatts. When greater power output is realized, it will be possible to project these radio waves effectively from a tube no bigger than a flashlight.



Tough web of synthetic rubber in the collet, shown below in exploded view and in section, extends the range of sizes over conventional designs. The

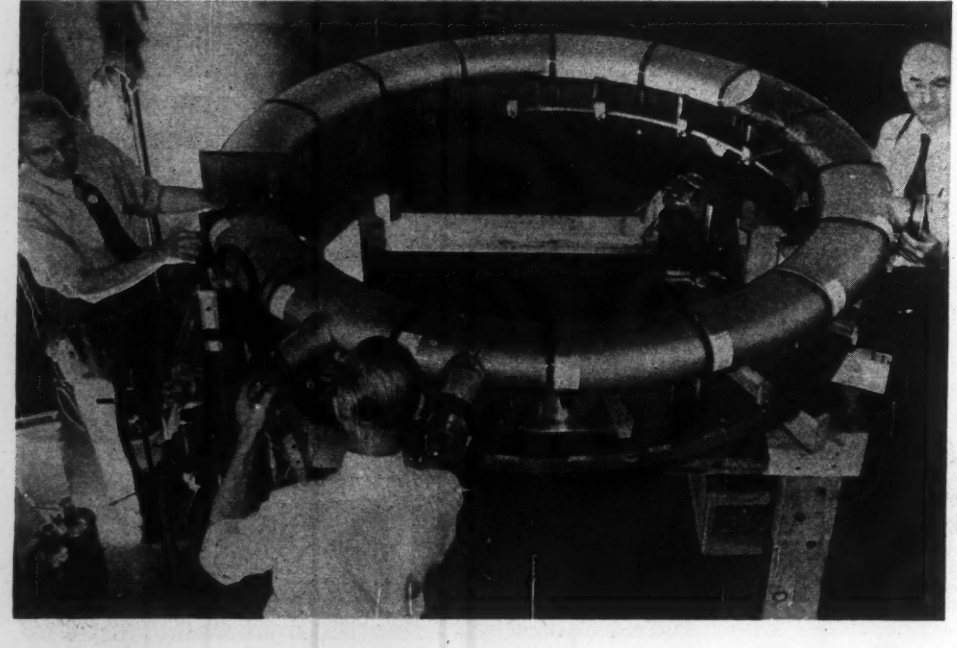




At Maximum Capacity *At Minimum Capacity*

rubber is bonded to the steel jaws and passes through anchoring holes in such a way as to make the inner unit a compact, conical unit. As the nut is tightened its tapered inner face displaces the jaws inward while the resilient web keeps them in alignment. Neoprene was selected for the web because of its oil resistance, all-around toughness and low degree of permanent deformation, important in maintaining alignment. The design is such that it is self tightening with a toggle-like action.

Radiations formerly available only in the cosmic rays can now be generated in the laboratory by a "betatron" or electronic accelerator. Shown below is a betatron built by General Electric which utilizes an electromagnet made of 130 tons of laminated silicon steel. As electricity at 24,000 volts surges through the electromagnet from a bank of condensers it produces an intense magnetic field concentrated in the horizontal space between its polefaces. Heart of the machine is a doughnut-shaped vacuum tube shown in bottom illustration. Made of 16 sectors of molded and tempered pyrex glass it is 74 inches in diameter. To make the inner surface of the tube an electrical conductor so that it would not accumulate a charge to interfere with the paths of the electrons within, it was sand-blasted and then silvered.



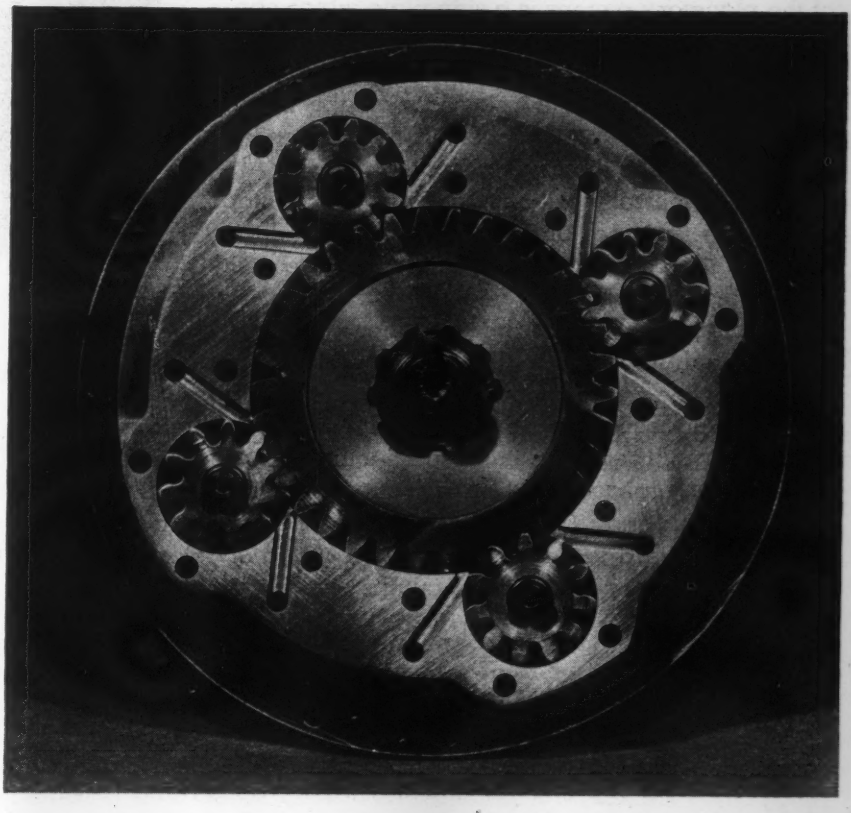
Projecting into the doughnut at one point is an electron gun, consisting of a heated filament from which electrons are boiled off, to be given an initial impulse of several thousand volts to start them in their orbits inside the doughnut. The magnetic field holds them in a fixed circular orbit as they gain speed and energy on successive revolutions, gaining about 400 electron volts each trip. Acceleration of the electrons is confined to the first quarter of each cycle, lasting about 1/240-second. At the end of the quarter cycle a pulse of current passes through two small auxiliary coils on the pole faces, causing the electrons to spiral away from their orbit and to hit a tungsten target. This causes generation of 100,000,000-volt X-rays which emerge from the doughnut in a 2-degree beam.

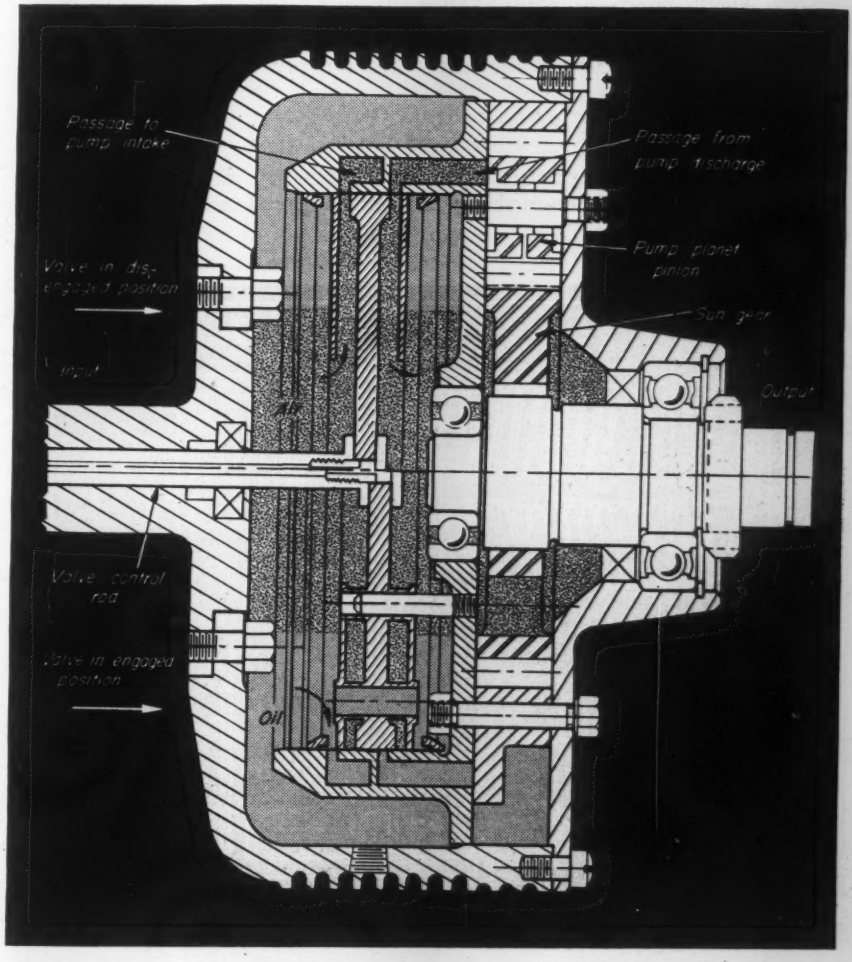
The possibility of using a magnetic field in this way to impart high velocity to electrons was discussed by a German, R. Wideroe, and in 1929 by an Englishman, E. T. S. Walton. In 1937 a U. S. patent was issued to Max Steenbeck of the Siemens Schuchert Works in Germany on a device embodying the principles set forth by Wideroe and Walton.

Hydrostatic pressure is employed in a unique type of variable-speed control and clutch unit which utilizes multiple gear pumps, acting as sun and planet gears, to obtain speed reduction. The planetary gear and pump assembly for this unit is illustrated at right and an axial section (rotated) is shown below. Developed by Brad Foote Gear Works, Cicero, Ill. the unit is a fully-enclosed mechanism containing both air and hydraulic fluid as the transmission medium. When the unit is disengaged the pinion gears pump air freely and transmit no power to the sun gear on the output shaft. As the valve control is shifted toward engaged position oil is progressively admitted to the pumps, building up back pressures on the pump pinions proportionally to the valve setting. At the extreme position of engagement the pinions are virtually locked by the pressure and full speed is transmitted. Output speed may be controlled by positioning the valve manually or automatically with a centrifugal governor. Also torque-overload control may be provided by incorporating a relief valve in the system to limit the pump pressure.

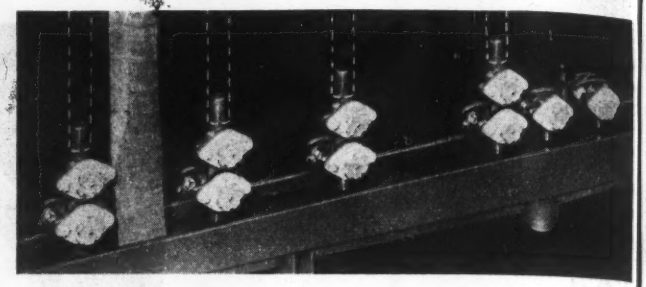
In operation, a core of air is contained in the central portion of the unit and a liquid annulus is held out against the side by centrifugal force. Upper half of the drawing shows the unit sectioned through one of the planet gears and with the valve in disengaged position. The lower section is rotated 45 degrees and shows the valve in the engaged position.

The parts consist of an end plate having pins to support the planetary pinions. At the center of the plate is an antifriction bearing to support one end of the driven shaft. On this shaft is keyed the sungear so placed as to mesh with the planetary pinions. A gear body fits closely around the gear set and is slightly thicker than the gears. Supporting the other end

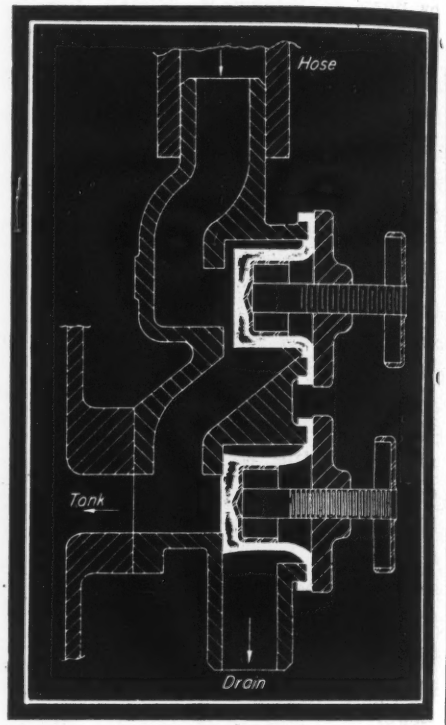




of the planetary pinions is a side plate which contains a valve seat and is provided with passages connecting each pump to the valve ports. Axial position of the valve, which seats on the inside wall of this side plate, is externally controlled through a bore in the driving shaft.

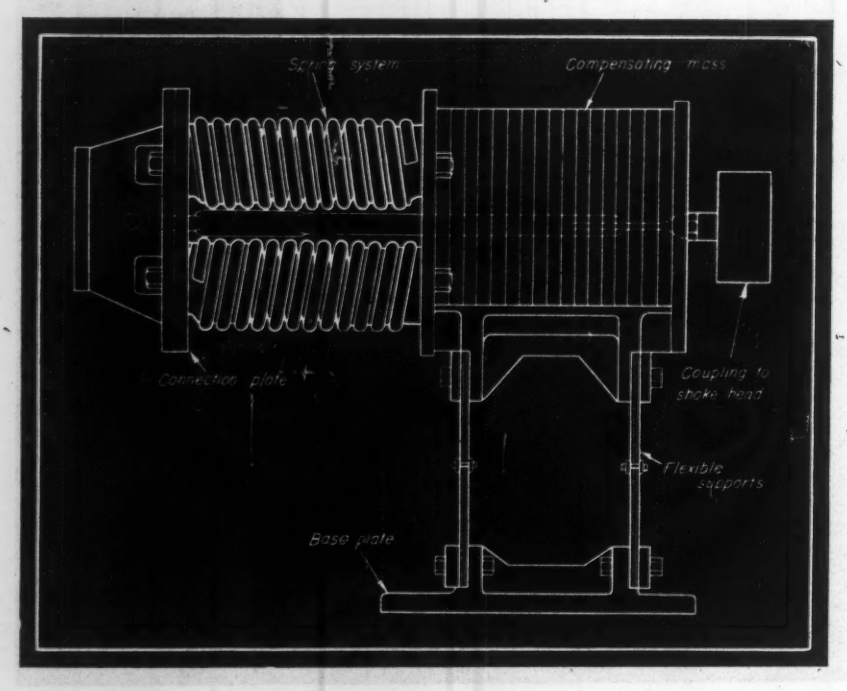


For the neutral position illustrated in the top half of the sectional drawing the valve conducts air from the center portion up to the valve seat where it is drawn into the gears by suction, transferred around the gears, back to the valve seat, then through the valve to the air core in the central portion of the clutch. As the valve is moved toward its engaged position, shown in the lower section of the drawing, the air supply is diminished and the liquid begins to enter the circuit. By proper phasing of these valve passages and valve seat ports, any combination of air and liquid may be admitted into the pumps. Movement of the valve toward the engaged position gradually closes the discharge ports, causing the gear pumps to build up pressure.



Cup diaphragm serves as valve, packing gland and gasket in the valves shown above, designed by Pako Corp. for use in chemical tanks. As shown in the drawing at right, the valve stem is pivoted in a cup liner so that the wiping action and twisting of the rubber cup on its seat is a minimum, thus insuring long valve life. Body of the valve is Heresite, a phenolic plastic which is impervious to the chemical solutions employed. Being a dual valve, it serves for both filling and draining the tank through one gasketed flange connection on the tank side. When each valve is open, both the developer tank and supply tank are drained.

Resonance in a compensator for a shaking mechanism, such as on fourdrinier paper-making machines, provides for increased shake frequency and reduced back thrust on the shake connecting rod. A schematic diagram for such a resonant compensator designed by the Submarine Signal Co. is illustrated at left. The system substitutes powerful springs and a compensating mass floating on flexible mountings for conventional "brute force" methods. During operation the shaker and the mass of the compensator are always moving in opposite directions and their energy is always balanced. As the springs are extended they release their energy to the two masses; as they are compressed they absorb the energy of the masses. Thus at any desired speed the motion of the shaker will be smooth. With this spring system the shake head simply acts like the main spring of a watch and supplies a little energy during each stroke.



How Cumulative Damage Affects Fatigue Life

By Milton A. Miner
Douglas Aircraft Co. Inc.

PROGRESS with methods of fatigue analysis has been slow because of lack of basic information on material behavior and, more important, because no method of handling any but the simplest problem has been available. Any solution requires several tools before other than a simple comparative analysis based on tests can be made. These tools must provide:

1. Information on the loading conditions to be encountered
2. Information regarding the number of cycles to failure of the material or part at various stresses (*S-N* curves)
3. Means for evaluating the cumulative effects of cycles of stress at various stress levels
4. A method of relating various loading cycles (i.e., cycles of stress with different ratios of minimum to maximum stress).

This article deals principally with Item 3, a means for evaluating the cumulative effects of cycles of stress at various stress levels. Item 4, which is supplemental to Item 3, also is dealt with since it is necessary in most practical problems.

Consideration of previous approaches (1)*, (2) and (3) led to an attempt to simplify the various phases of the damage problem in fatigue. Since aircraft structures are made mainly of aluminum alloys, this material was chosen for the tests. Also, inasmuch as the appearance of a crack in an airplane structural member requires repair or replacement before further operation is possible, a crack can be considered as a failure in such a part. To account for the effects of stress cycles above some arbitrary lower limit (for convenience, the stress at $N = 10^7$) a simple concept of damage was considered. This concept held that the damage could be expressed in terms of the number of cycles applied divided by the number to produce failure at a given stress level. When the summation of these "increments of damage" at several stress levels became unity, failure would occur.

ASSUMPTIONS AND LIMITATIONS: The complexity of loadings encountered in aircraft makes any approach to a fatigue analysis approximate at best. Therefore, the following simplifying as-

Fig. 1—Below—Modified Goodman diagram. Stress ratio, R, equals ordinate of line C divided by ordinate of line A

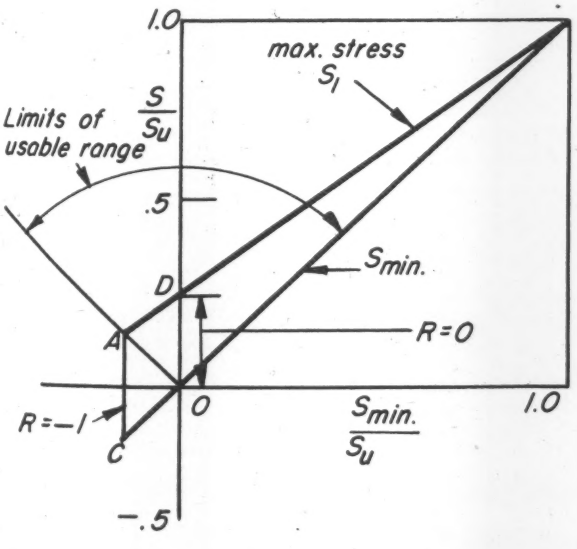
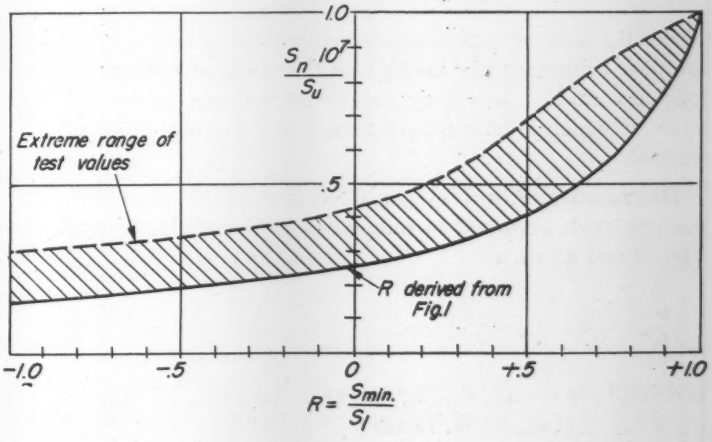


Fig. 2—Right—Stress at ten million cycles (as fraction of ultimate tensile strength) versus stress ratio, showing comparison of test results with derived relation from Fig. 1



Abstract of a paper presented at the recent Aviation meeting of the American Society of Mechanical Engineers, in Los Angeles.

* Numbers in parentheses refer to references at end of article.

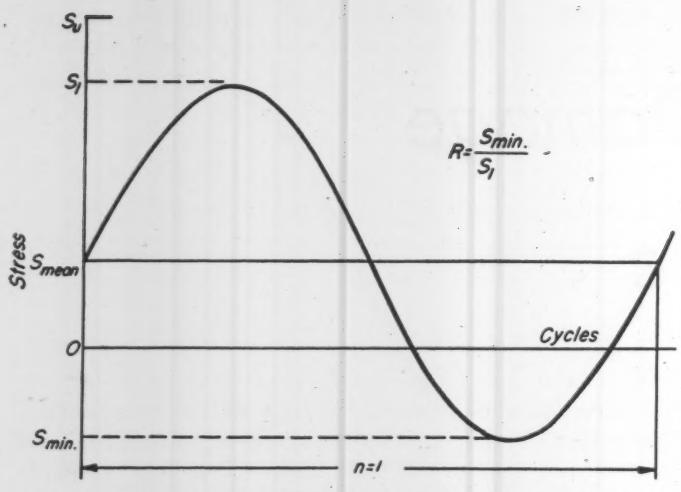
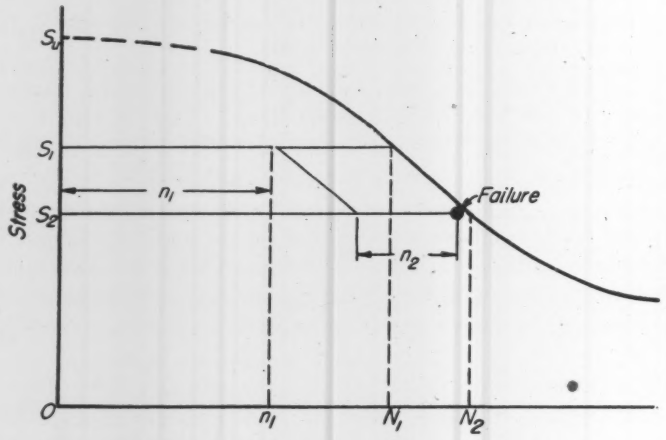


Fig. 3—Above—Assumed loading cycle, illustrating notation for one complete cycle of stress

Fig. 4—Below—Typical S-N curve, showing failure point due to loading at two different maximum stress levels



sumptions are made so that a start is possible:

1. Loading cycle is sinusoidal
2. Total amount of work that can be absorbed produces failure (under the further assumption that no work hardening occurs)
3. Relationship between various stress ratios (ratio of minimum stress to maximum) is approximately as shown in *Figs.* 1 and 2 (4)
4. Inception of a crack, when observed, is considered to constitute failure.

For the sake of experimental brevity, these assumptions are also subject to the limitations that only aluminum alloys are studied and only maximum stresses above the stress at which fatigue failure occurs at 10^7 cycles are considered.

DEVELOPMENT OF DAMAGE CONCEPT: If W represents the net work absorbed at failure, (see Nomenclature and *Figs.* 3 and 4) then

$$\frac{w_1}{W}=\frac{n_1}{N_1} \quad \ldots\ldots (1)$$

and similarly for w_2, n_2, N_2, etc. For failure, $w_1 + w_2 + w_3 + \ldots + w_n = W$, hence

$$\frac{w_1}{W}+\frac{w_2}{W}+\frac{w_3}{W}+\ldots+\frac{w_n}{W}=1 \quad \ldots\ldots (2)$$

Substituting values from Equation 1,

$$\frac{n_1}{N_1}+\frac{n_2}{N_2}+\frac{n_3}{N_3}+\ldots+\frac{n_n}{N_n}=1 \quad \ldots\ldots (3)$$

or

$$\sum\frac{n}{N}=1 \quad \ldots\ldots (4)$$

This expression has been demonstrated to hold true experimentally within the limits of the assumptions. It should be noted that the significant feature of the cumulative damage concept lies in the hypothesis that failure occurs when $\Sigma(n/N) = 1$.

EXPERIMENTAL VERIFICATION: In *Fig.* 5 are shown the types of specimens employed in the experiments. All

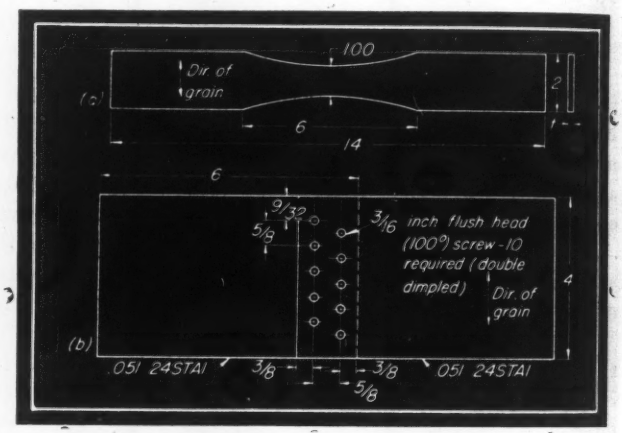
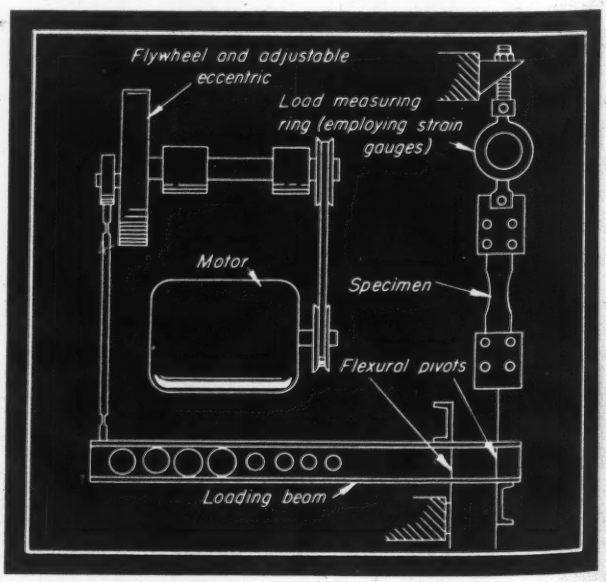


Fig. 5—Above—Flat sheet (a) and dimpled flush screw (b) specimens used in verifying fatigue damage concept

Fig. 6—Below—Typical fatigue-testing setup



Nomenclature

Referring to *Figs* 3 and 4:

S = Maximum or minimum stress
S_u = Ultimate static tensile strength
S_1 = Maximum stress in a loading cycle (i.e., the stress of greater magnitude regardless of whether it is tension or compression)
N_1 = Number of stress cycles to failure at stress S_1
n_1 = Number of cycles applied at S_1
W = Work done to failure
W_1 = Work done at n_1 cycles
S_{min} = Minimum stress in a given loading cycle (may be any value less than S_1, either tension or compression)
R = S_{min}/S_1 = Ratio of minimum stress to maximum stress in a loading cycle.

specimens were made from Alclad 24ST sheet material.

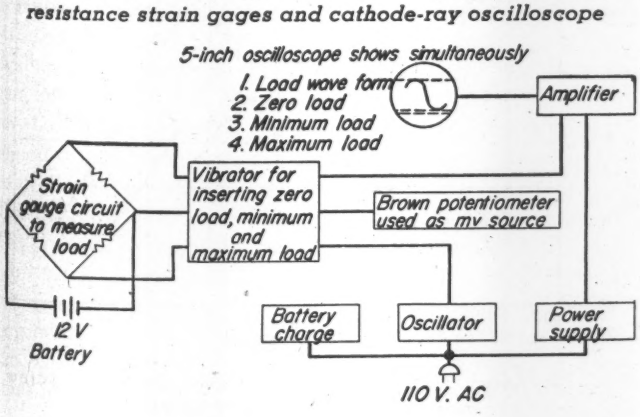
Equipment used to perform these tests was essentially the same as that shown in the line diagram of *Fig.* 6. Positive dynamic load control was maintained through the use of electrical resistance strain gages coupled in series with the test specimen and indicating on a DuMont type 208, 5-inch tube cathode-ray oscilloscope (*Fig.* 7).

The basic *S-N* curves are shown in *Fig.* 8. Stress ratio values, R, (see Nomenclature) of +0.50, +0.20, and −0.20 determined experimentally are presented. *Fig.* 9 is a reproduction of a portion of *Fig.* 8 with results plotted for three typical specimens from TABLE I. *Fig.* 9 is plotted to illustrate graphically the loading cycles employed and the agreement of the final failure with the cumulative damage concept.

Method of plotting the cumulative cycles in *Figs.* 9, 10 and 11 is based on the proportion n/N. At any ratio n_1/N_1, a percentage of useful life has been consumed. This proportion is used to determine the starting point of n_2 at a different stress. Thus specimen S19 (TABLE I and *Fig.* 9) was run at 33,300 psi for 135,000 cycles. At this stress the number of cycles to failure is N_1 = 243,000 cycles, therefore n_1/N_1 = 135,000/243,000 = 0.55. The specimen was then run at the lower stress of 29,600 psi, at which the equivalent cycles would be 0.55 x N_2 = 0.55 x 330,000 = 181,000 cycles—the point from which n_2 starts on *Fig.* 9. Now since n_2 = 141,000 cycles at failure, n_2/N_2 = 141,000/330,000 = 0.43 and $\Sigma(n/N)$ = 0.55 + 0.43 = 0.98. The same procedure is used to plot the other points serving as examples.

In TABLE I are presented the results of a number of

Fig. 7—Below—Load control circuit employing electrical resistance strain gages and cathode-ray oscilloscope



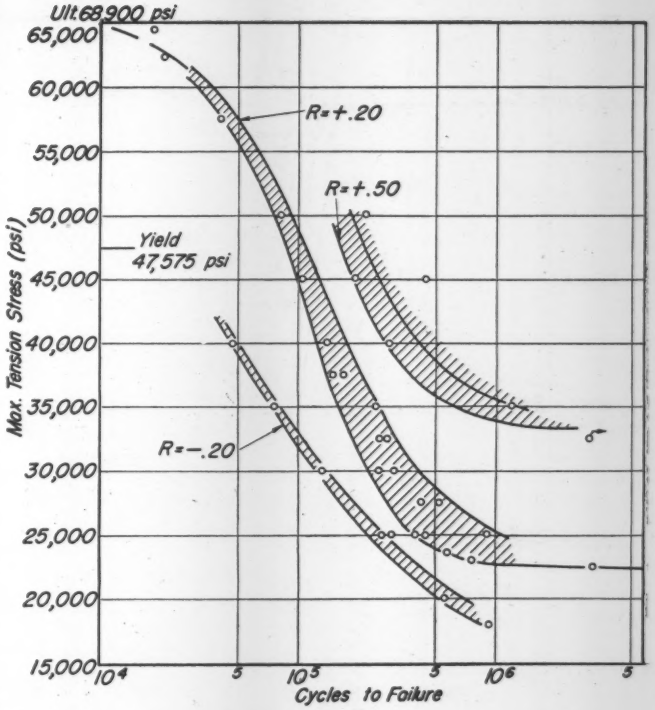


Fig. 8—S-N curves at various R values for flat sheet fatigue specimen of Alclad 24ST

experiments all of which were run at two or more stress levels at a stress ratio of +0.20. The average test value for $\Sigma(n/N)$ is 0.98, the maximum and minimum values

TABLE I

Test Results with R = +0.2

Specimen*	S_1, psi	n/1000	N/1000	n/N	Σn/N‡
S-19-A	33,300	135	243	0.55	
	29,600	141	330	0.43	0.98
S-20-A	33,300	135	243	0.55	
	25,000	306	640	0.48	1.03
S-21-A	33,300	135	243	0.55	
	22,500	1330	3000	0.44	0.99
S-22-A	30,000	180	320	0.56	
	33,300	108.8	243	0.44	1.00
S-40-A	30,000	128	320	0.40	
	50,000	29.9	85	0.35	0.75
S-42-A	30,000	108	320	0.34	
	27,500	97.5	420	0.23	
	32,500	9.1	260	0.04	0.61
S-43-A	25,000	102.5	640	0.16	
	35,000	55.5	215	0.26	
	27,500	97.5	420	0.23	
	32,500	26.9	260	0.10	0.75
S-48-A	35,000	100	215	0.46	
	30,000	100	320	0.31	
	27,500	230	420	0.55	1.32
S-49-A	27,500	200	420	0.48	
	30,000	80	320	0.25	
	35,000	82.5	215	0.38	1.11
1-B	4300†	7.2	31.5	0.44	
	3515†	15.6	64	0.24	
	2735†	120	155	0.77	1.45
2-B	2735†	72	155	0.46	
	3515†	20	64	0.31	
	3900†	1.2	45	0.03	0.80

*Specimen type *A* illustrated in *Fig.* 5*a*, type *B* in *Fig.* 5*b*.
†Load in pounds.
‡At failure. Average value 0.98 for table.

being 1.45 and 0.61. If only the last cycle of loading is plotted for these tests (assuming that only this final stress cycling caused the failure), the average value of n/N is 0.37, thus indicating that the damage from the other loading cycles cannot be ignored.

Represented in *Fig.* 10 is a more complex type specimen —a dimpled flush screw joint—in which the *S-N* curve

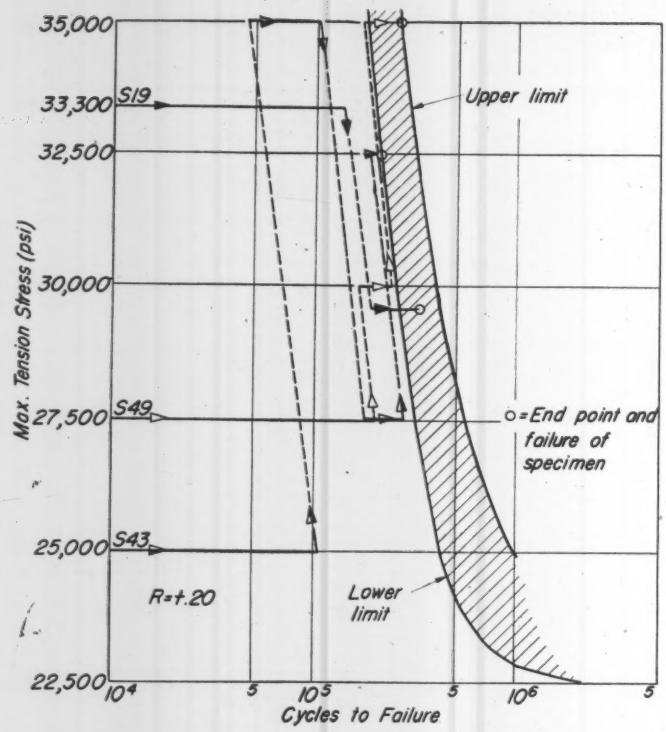


Fig. 9—Partial reproduction of Fig. 8, showing graphical presentation of cumulative damage concept

has been established and two tests have been run at different stress levels. Incidentally, the author believes that "stress-raisers" or stress concentrations are best handled in fatigue by experimentally establishing *S-N* curves on specimens or parts which contain the actual concentrations wherever possible. Applying factors or corrections does not seem feasible at the present time.

RELATING VARIOUS STRESS RATIOS: By use of a modified Goodman diagram, *Fig.* 1, the fatigue characteristics of a material or part can be compared even though the information available has been obtained for varying ratios of minimum to maximum stress. Although experiments with Alclad 24ST aluminum alloy specimens do not result in a straight line such as that of *Fig.* 1, the variation is not great. In *Fig.* 2, the lower limit curve bounding the shaded area has been obtained from *Fig.* 1. It is useful in presenting a cross-plot of stress (expressed as a percentage of the ultimate tensile strength) against stress ratio, *R*, for a given number of cycles. The upper curve of the shaded area represents the maximum deviation of test values of various experimenters including some unpublished data on Alclad 24ST material. Thus it is apparent that the lower curve is in fair agreement with experiments and gives conservative stress values. Also the economy and simplicity of handling of particular problems using the straight line are greatly improved since the large numbers of tests necessary to establish several *S-N* curves thus can be avoided. For the purposes of this paper, *S-N* curves at various *R* values have been experimentally established (*Fig.* 8) so that the accuracy of the damage concept can be ascertained.

TABLE II

Test Results with R Changed

Specimen*	R	S_1, psi	n/1000	N/1000	n/N	Σn/N†
S-38-A	—0.20	35,000	33	80	0.41	
	—0.20	27,500	108.7	187	0.58	0.99
S-39-A	—0.20	27,500	127	187	0.68	
	—0.20	40,000	6.3	48	0.13	0.81
S-54-A	—0.20	40,000	20	48	0.42	
	+0.20	40,000	50	155	0.32	
	+0.50	40,000	143	430	0.30	1.04
S-55-A	—0.20	30,000	40	137	0.29	
	+0.20	32,500	80	260	0.31	
	+0.50	40,000	80	430	0.19	0.79
S-56-A	—0.20	35,000	40	80	0.50	
	+0.20	32,500	149.5	260	0.57	1.07
S-57-A	—0.20	37,500	40	63	0.64	
	+0.20	25,000	423	640	0.66	1.30
S-58-A	+0.20	25,000	312	640	0.49	
	—0.20	37,500	56.8	63	0.90	1.39
S-59-A	—0.20	40,000	30	48	0.63	
	+0.20	26,700	83	460	0.18	0.81
S-60-A	+0.20	26,700	200	460	0.43	
	—0.20	40,000	46.2	48	0.96	1.49
S-62-A	—0.20	40,000	35	48	0.73	
	+0.20	26,700	32.5	460	0.07	0.80
S-63-A	+0.20	25,000	350	640	0.55	
	—0.20	37,500	23.8	63	0.38	0.93

*Specimen type *A* illustrated in *Fig.* 5*a*.
†At failure. Average value 1.05 for table.

When Stress Ratio Is Changed

In TABLE II are presented results of experiments in which a percentage of damage was imposed upon a specimen at one stress ratio, *R*, then in most cases the stress ratio and load were changed and the specimen tested until failure occurred. In several cases three different stress ratios were employed both in the positive and negative range (i.e., both tension-tension and tension-compression loads). As in the case of tests run at a constant stress ratio, the value of *N* is taken directly from the *S-N* curve, the difference here being that *S-N* curves are required for each stress ratio.

In *Fig.* 11 are presented several of the results from TABLE II in graphical form. It is to be noted that the average value of $\Sigma(n/N)$ is 1.05 for these experiments.

Accuracy of test results is particularly important in attempting to establish damage information. Small inaccuracies in loading (which are not so likely in rotating beam machines, but are common in axial-loading types) will re-

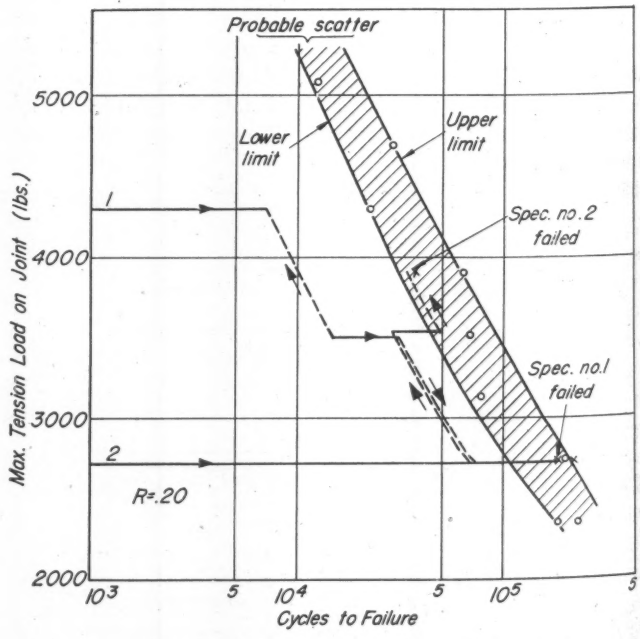


Fig. 10—Load cycle curve for 3/16-inch flush screw dimpled joint in Alclad 24ST

sult in large variations in the number of cycles to failure. Considering the usual large scatter, the results obtained in the tests of TABLES I and II are felt to be both accurate and significant. The average value for $\Sigma(n/N)$ is 1.015 for the twenty-two specimens, the maximum and minimum values being 1.45 and 0.61 respectively. Inspection of an *S-N* curve on which are plotted actual test points will show that the scatter of these maximum and minimum values is not excessive (see *Fig.* 158, Page 202 of Ref. 2).

Concept Applied to Hydraulic Unit

SAMPLE ANALYSIS: The problem is to find the expected life in hours of a hydraulic pressure unit, assuming that the pressure vessel is made of aluminum alloy and operates from 1500 to 3000 psi during part of its operation and from 600 to 3000 psi during the remainder. The system operates at 20 cycles per minute under accelerated test conditions and 60 per cent of these operating cycles are of the former type. At 3000 psi pressure, the maximum tensile stress is known to be 35,000 psi in the critical region.

SOLUTION: Now $R_1 = 1500/3000 = +0.50$ and $R_2 = 600/3000 = +0.20$. Also $n_1 + n_2 = 20$ cpm or, effectively, $n_1 = 0.6 \times 20 = 12$ cpm and $n_2 = 0.4 \times 20 = 8$ cpm.

From an *S-N* curve for the material in question (values are assumed for this example), $N_1 = 1{,}000{,}000$ cycles to failure at 35,000 psi and $R = +0.50$; and $N_2 = 215{,}000$ cycles to failure at 35,000 psi and $R = +0.20$. Also, the portion of total life consumed per minute of operation is

$$\frac{n_1}{N_1}+\frac{n_2}{N_2}=\sum\frac{n}{N}$$

or

$$\frac{12}{100\times10^4}+\frac{8}{21.5\times10^4}=0.49\times10^{-4}$$

and since failure occurs at $\Sigma(n/N) = 1$, the pressure unit can be expected to fail in $(1/60) \times (1/0.000049) = 340$ hours of continuous operation under these accelerated conditions.

Of course for an actual case there are several problems which arise to make the determination of fatigue life anything but simple such as the example illustrated. Determination of the working stress and number of cycles of operation is usually a difficult matter involving precise instrumentation and careful experimental work or a careful evaluation of service experience and the other factors that can be determined. Then too, *S-N* curves are required for the particular part in question. However, if the critical region of the part is known to have negligible stress concentration, *S-N* curves of the basic material can be used. The modified Goodman diagram of *Fig.* 1 or the curves of *Fig.* 2, provide a useful means of relating various stress ratios at $N = 10^7$ but test curves are still to be preferred for greater accuracy. It should be noted that when experimental curves are to be established, many actual cases are handled most economically with an *S-N* curve of constant mean stress (i.e., with the stress ratio varying) rather than a number of *S-N* curves for constant values of *R*.

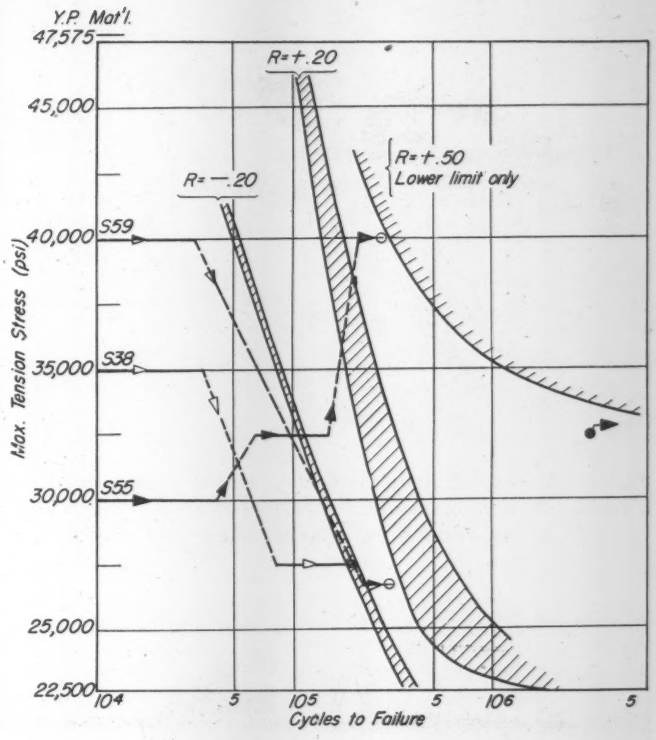


Fig. 11—Partial reproduction of Fig. 8, showing graphically the failing points for specimens with stress, stress ratio, and number of cycles all varying

An actual problem involving aluminum hydraulic pressure accumulators has been successfully solved by the procedures outlined. The accumulators were made of forged 14ST aluminum alloy for which basic material *S-N* curves were available. Test runs on the accumulators indicated that a relatively small number of cycles occurring at a lower stress ratio but at the same maximum stress might be causing premature failures. Analysis of the various possibilities for fatigue failures in the different type systems in which the accumulators were used indicated that one system was entirely satisfactory while another was not. Actual service experience proved the analysis to be correct in both cases. A long history of satisfactory service existed in one case while in the other several failures had occurred in a relatively short length of time.

CONCLUSIONS: From the evidence available at present, it is concluded that the concept of cumulative damage:

1. Holds true for Alclad 24ST aluminum alloy and probably for the other high-strength aluminum alloys
2. Provides a simple, practical (and conservative) means for analyzing fatigue problems
3. Should be experimentally investigated for steels and other materials to determine its range of usefulness.

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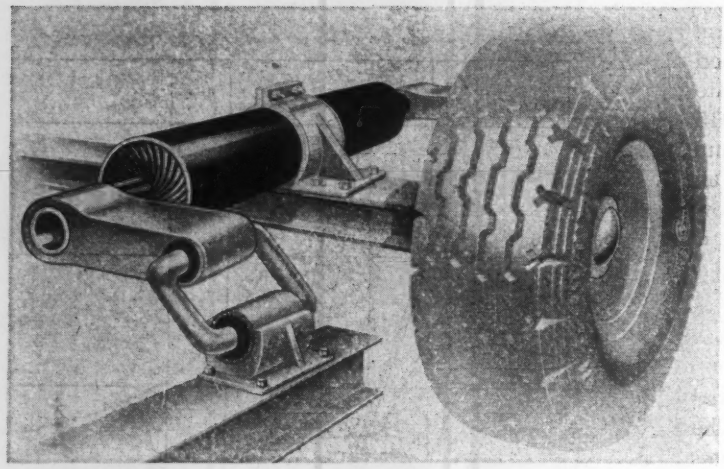


Fig. 1—Above—Rubber instead of metal spring suspension for a truck. In this application a rubber bushing, flexed in torsion, is bonded to a metal shell and shaft

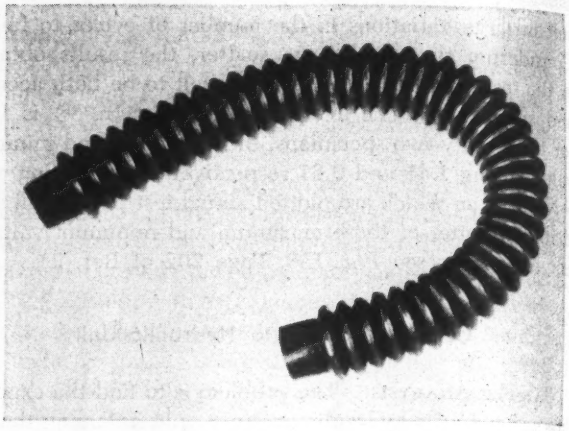


Fig. 4—Above—Hose used in respirators and gas and oxygen masks is molded of natural rubber which has high tensile strength, good resistance to cold and aging, good flexibility, and is nontoxic

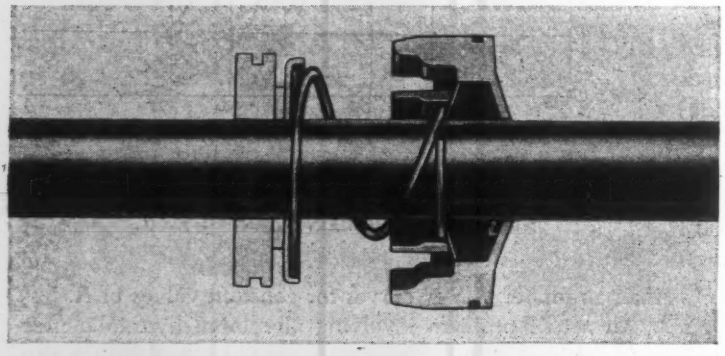


Fig. 2—Above—Cross section of hydraulic shock-absorber piston shows how nitrile synthetic-rubber seal is used to retain light oil and resist abrasion as piston moves back and forth on bar

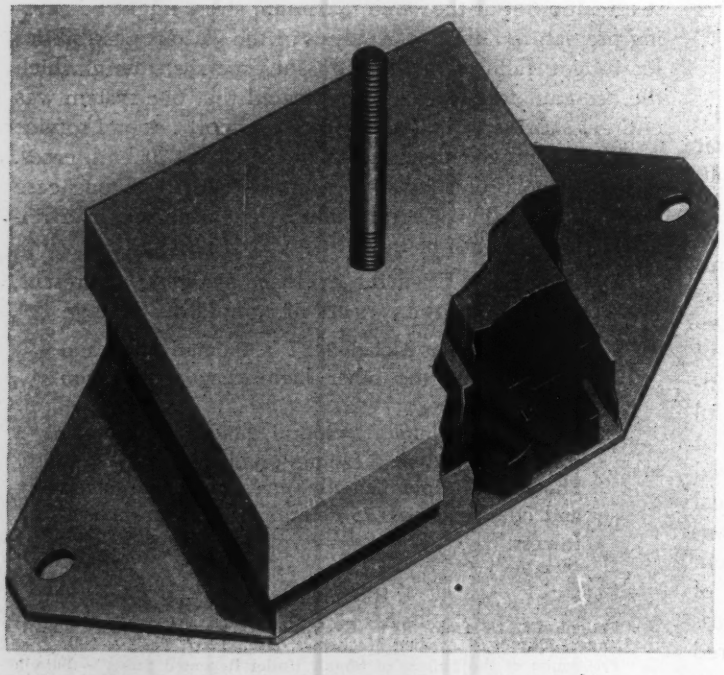
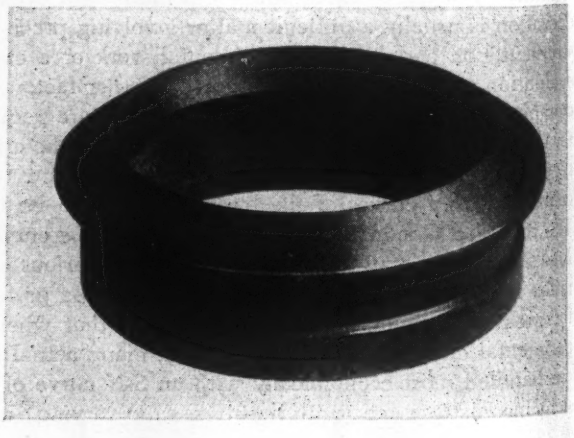


Fig. 3—Above—One of the many types of vibration mounts available, this unit combines rubber in shear and in compression. Nitrile synthetic rubber employed is oil resistant, has low permanent set and good fatigue strength

Rubber Ma

WHILE literally thousands of synthetic rubber compounds have been developed, in general those used most extensively for machine parts are of five basic types, i.e., Buna-S, Buna-N, Neoprene, Butyl and Thiokol. Those of the Buna-S type, also known as GR-S (Government Rubber S) are co-polymers of butadiene and styrene. Similar to natural rubber in processing and performance characteristics, they can be vulcanized with sulphur and rubber accelerators and cured to hard rubber. Their resistance to deterioration in air both at room temperature and elevated temperatures is considerably better than natural rubber. Since synthetics of the Buna-S type have excellent electrical

Fig. 6—Below—Gasket for coffee maker is typical of many types used in household appliances. Molded of Neoprene synthetic rubber, it is odorless, tasteless, nontoxic, and has good resistance to heat



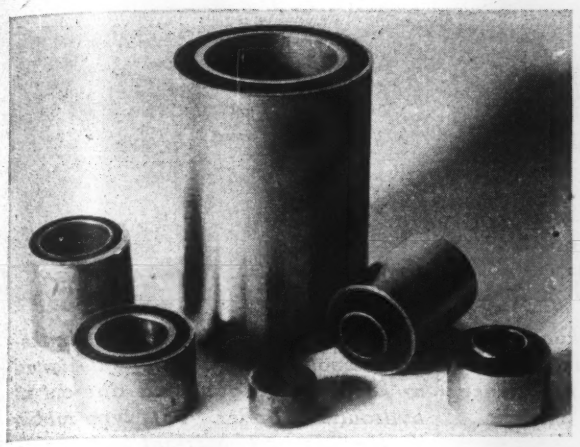


Fig. 5—Above—Shaft bearings made of two concentric metal sleeves between which is a longitudinally stretched rubber bushing mechanically bonded to the sleeves

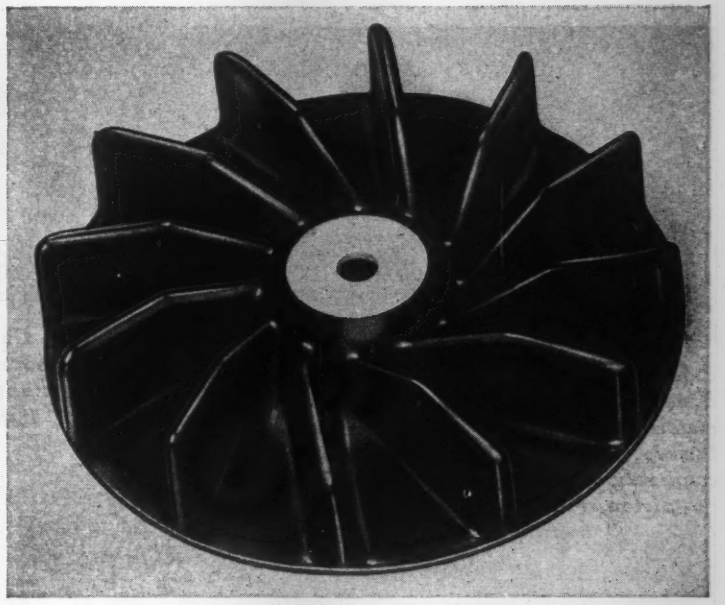


Fig. 8—Above—Metal pump impeller coated with anode rubber which is applied as liquid latex by a process much the same as electroplating. Anode rubber offers good abrasion resistance, resistance to chemicals, and is an excellent insulator

Machine Parts

properties, they are used widely for electric cable insulation. Also, they are suitable for water-pump seals and gaskets, but not for oil equipment.

Synthetics of the Buna-N type (commonly referred to as nitrile rubber) are co-polymers of butadiene and acrylonitrile. Like the Buna-S type, they are similar to natural rubber in that they can be vulcanized with sulphur and rubber accelerators and may be cured to hard rubber. They offer excellent resistance to oil and good "breakaway" properties in contact with metals. In other words when used, for example, for seals on a hydraulic piston, there is little tendency for the rubber to stick to

Fig. 9—Above—This patented valve permits air or gas to flow freely in one direction with complete seal in opposite direction in gas mask. Compounded of natural rubber, it is nontoxic

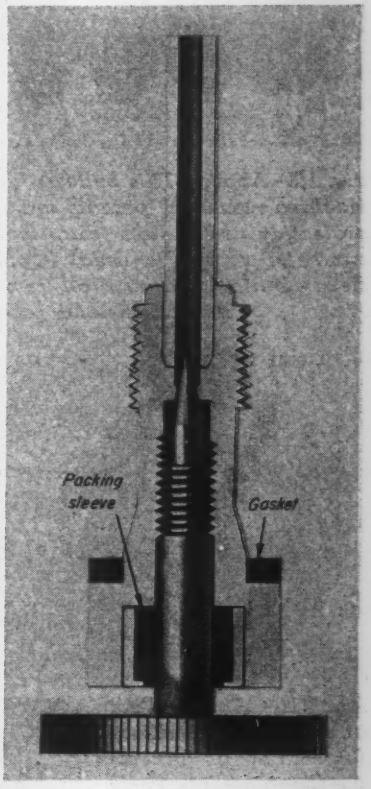


Fig. 10 — Right — Carburetor jet assembly of portable gasoline engine is designed to use all grades of gasoline at extreme weather conditions. Packing sleeve, of nitrile synthetic rubber, does not swell or lose sealing effectiveness

Fig. 7—Below—Piece cut from a beverage-cooler seal is representative of the countless intricate shapes that can be extruded from many types of natural and synthetic rubber

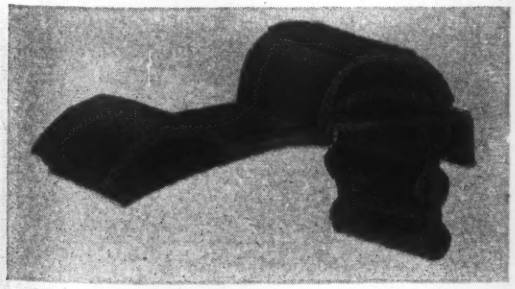


Fig. 11 — Right — Three typical automotive water-pump shaft seals. These, molded of Buna-N synthetic rubber, are oil, antifreeze and heat resistant, and will not swell

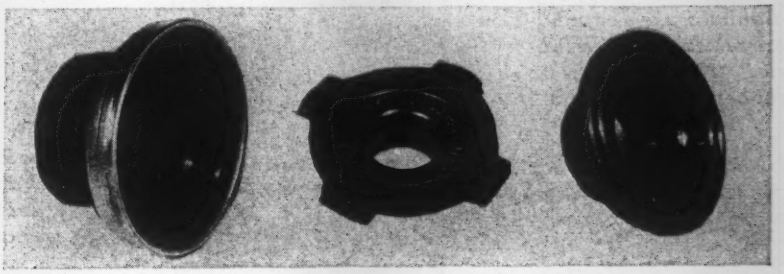


Fig. 12—Above—V-seal set molded of Buna-N type synthetic rubber consists of three V-seals and male and female adaptors. Typical V-seal applications are seals for piston heads or piston rods in pneumatic and hydraulic units

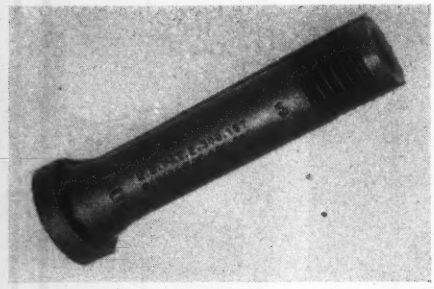


Fig. 13 — Above — Chicken picker finger. Molded of Neoprene synthetic rubber, it is resistant to grease, chemicals, heat, light and air

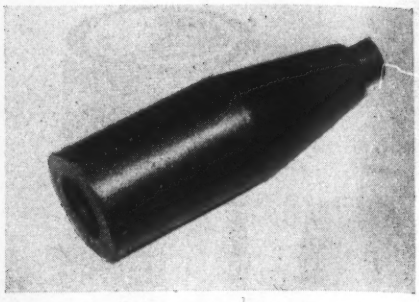


Fig. 14—Above—Automotive brake-cable boot molded of GRS is designed to keep water, dust and dirt out of hydraulic cylinder. This type rubber is flexible and resistant to freezing

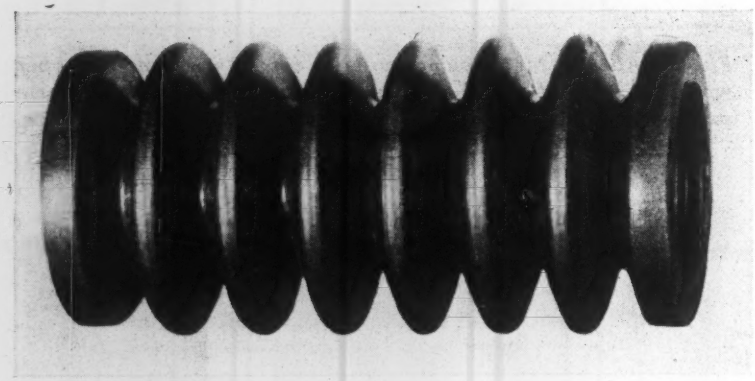
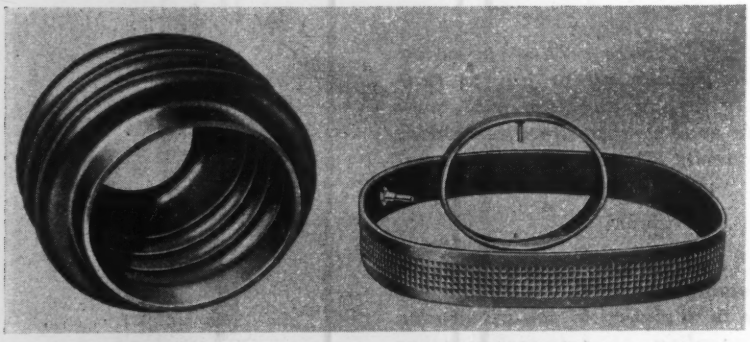


Fig. 15—Above—This bellows-type boot, when placed over moving machine members, permits unhampered movement of parts while protecting them from dirt, moisture and abrasion. Neoprene synthetic rubber is used, imparting good tensile strength and flexural life, moderate oil resistance, good tear or cut-growth resistance, and good abrasion resistance



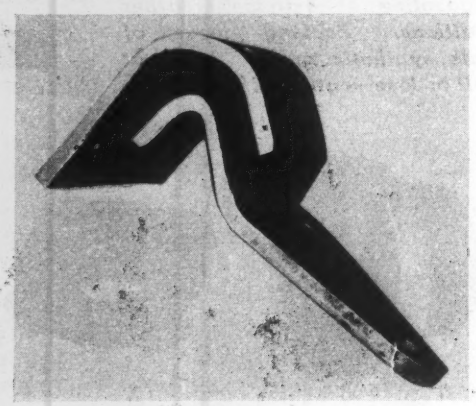


Fig. 16—Above—Part at left is molded bellows for sealing or protecting flexible joints. Parts at right are rubber hydraulic-brake expanders reinforced with fabric. Nitrile synthetic rubber is used in both applications

the metal cylinder. A few representative parts for which Buna-N synthetics are suitable are: Oil and gasoline hose, packings, gaskets, rubber-covered rolls, valve inserts, molded dust seals, diaphragms for hydraulic gear shifts, hydraulic lines, vibration dampeners, etc.

Neoprene-type synthetic rubbers were our first commercially successful type. They are polymers of chloroprene, are good general-purpose rubbers, offer good resistance to chemicals and oils, and have excellent resistance to heat, air and light. Their excellent flame resistance has led to their use as outer sheathing for electrical insulation, even though the electrical properties are lower than those of natural rubber. Typical applications are: Oil-resistant hose, belting, gaskets, fuel cells, solid truck tires, airplane tires, printing rollers, airplane hull and wing caulking, etc.

Co-polymers of isobutylene and small amounts

Fig. 18—Below—Water-lubricated rubber bearings such as this flanged, split type have outlasted metal and wood bearings in marine service. Particularly suitable in applications where oil or grease lubrication is impractical, they are highly resistant to abrasion

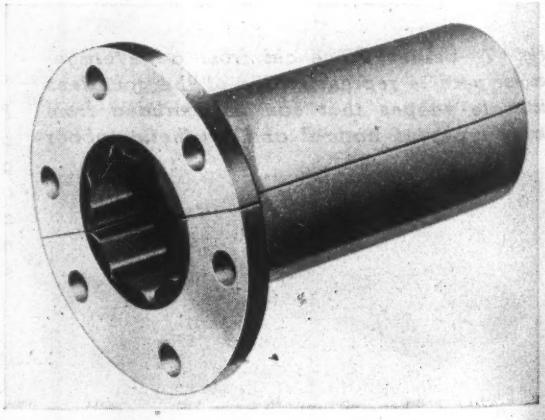


Fig. 17—Left—Good example of rubber-to-metal bonded parts is this automotive motor mount. Rubber used is GRS which has high adhesion and compression set as well as good vibration-damping characteristics

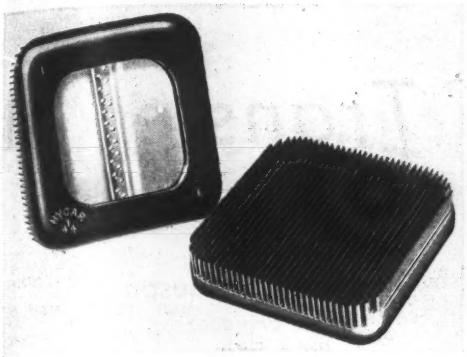


Fig. 19—Left—This intricate molded dauber is used in a cotton picking machine to remove cotton from the steel picking fingers. Nitrile synthetic rubber used is not greatly affected by the cottonseed oil it contacts over long periods of time

of other unsaturated hydrocarbons such as butadiene or isoprene, Butyl-type synthetics have processing characteristics comparable to natural rubber but require a longer curing time. They cannot be vulcanized to hard rubber. Their general resistance to deterioration is good and their resistance to oxygen and acid is very good, but their physical properties are lower than those of natural rubber. They are used advantageously in applications where good impermeability to gases is required and also where resistance to chemicals and oxidation is more important than properties such as tensile strength and resistance to cold flow. The Butyls serve splendidly in all types of acid-handling equipment and are also applicable to inner tubes where their air-holding ability is desirable.

Types A, FA and ST Thiokol polysulfide synthetic rubbers are made from dihalogenated organic compounds and inorganic polysulfide or combinations and modifications of these. They have excellent resistance to oils, greases, solvents, lacquer thinners, ozone, sunlight and natural aging. Their resistance to aromatic hydrocarbons and aromatic blended gasolines is better than that of natural rubber or other synthetics. In general, the Thiokols are used where resistance to deterioration is more important than physical properties. Some typical applications are: Paint spray and solvent hose, selector valve rings, diaphragms, cable covers, tank linings, etc.

Best way to select a rubber for any given application is to supply a rubber parts producer with detailed requirements of the job, basing final selection on his recommendations. In addition to information on the types and magnitudes of loading involved, he will need data on requisite resistance to heat, oils, water, ozone, abrasion, etc.

MACHINE DESIGN is pleased to acknowledge the collaboration of the following companies in this presentation:

Acadia Synthetic Products Div., Western Felt Wks. (*Figs.* 12, 21) ..... Chicago
Acushnet Process Co. (*Figs.* 4, 6, 9, 15, 20, 22) ..... New Bedford, Mass.
The B. F. Goodrich Co. (*Figs.* 1, 8, 18) ..... Akron, O.
Hamilton Kent Mfg. Co. (*Fig.* 3) ..... Kent, O.
Harris Products Co. (*Fig.* 5) ..... Cleveland
Hycar Chemical Co. (*Figs.* 2, 10, 16, 19, 23) ..... Akron, O.
The Johnson Rubber Co. (*Fig.* 7) ..... Middlefield, O.
The Ohio Rubber Co. (*Figs.* 11, 13, 14, 17, 24) ..... Willoughby, O.

Fig. 20—Below—This molded-rubber plug is typical of rubber parts used in electrical and ignition systems. Compounded of Buna-S synthetic rubber, it has good electrical resistance properties

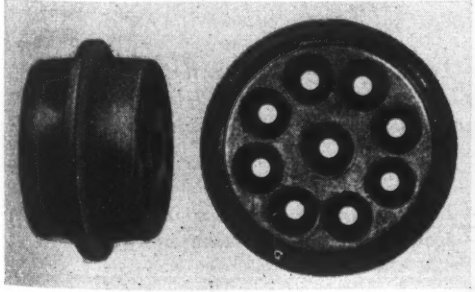


Fig. 24 — Right — Pillow-block shaft bearing in which rubber bushing compensates for shaft misalignment and dampens vibrations. Buna-N synthetic rubber is employed

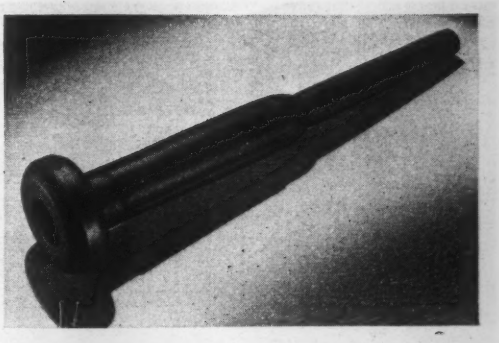


Fig. 21—Above—Milking inflation of Neoprene synthetic rubber imparts neither taste nor odor to milk and is unaffected by fat content of milk. Part has long flexural life and good cut-growth resistance

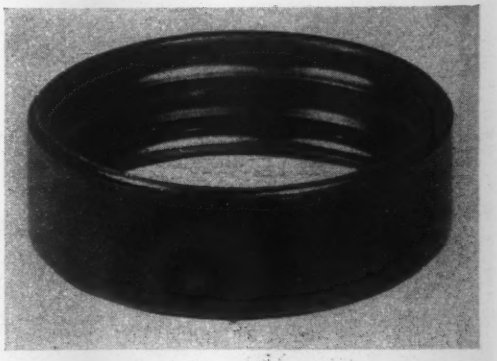


Fig. 22—Above—Intake-pipe connection seal for aircraft engines. Of Buna-N synthetic rubber, it has good resistance to gasoline and heat

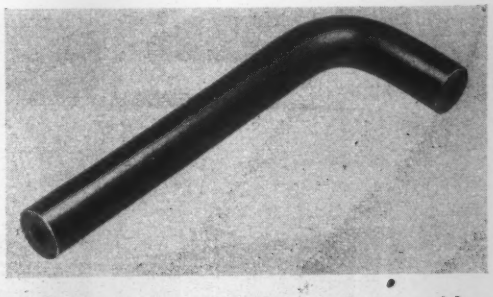
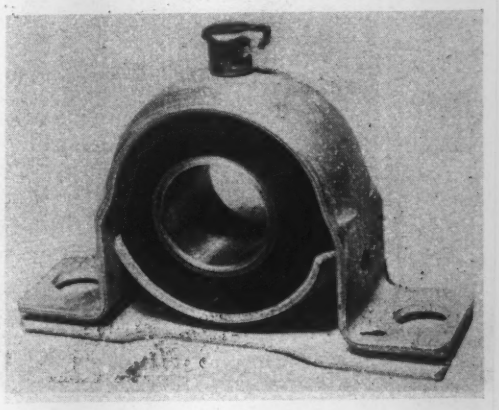
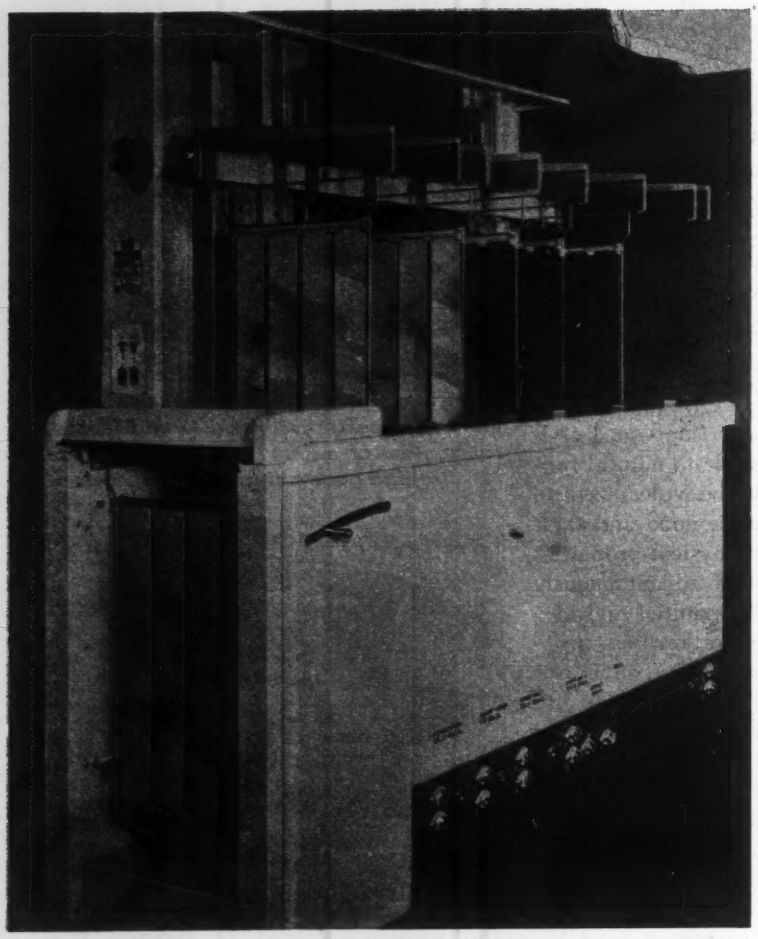


Fig. 23—Above—Nitrile synthetic rubber tube handles hydraulic fluid in system of automatic pilot for aircraft. Metal tube, formerly employed, broke at joints due to fatigue engendered by vibration





Transfer M

By Robert Sardeson
Chief Engineer
Pako Corp.

QUICK transfer of material from one container to the next involves an ingenious differential mechanism to avoid excessive sway of carrier frames or hangers. Such a mechanism is incorporated in the film developing machine, *Fig.* 1, which is designed to develop, fix, wash and dry. It consists of a loading magazine, a battery of seven chemical and wash tanks, an electrically-heated dryer, and the necessary conveyors to automatically carry the film through the entire processing cycle.

Hangers to support the film in the machine are specially designed for use with the conveying system. They are placed manually in the machine but from there on they are transferred from tank to tank, with a preselected timing interval, and ultimately are passed through the dryer without further effort from the operator.

Transfer in and out of the tanks is accomplished by an elevator bar and a series of arms fitted with downwardly extending hooked fingers as shown in *Fig.* 2. This bar is supported on roller carriages which permit both vertical and horizontal movement. It is carried on two closed chain loops, driven synchronously by a chain and sprocket system in the rear of the machine. Movement of the elevator bar and its attached parts is such that it is able to engage the top bar of a film hanger, lift it from one tank, move it horizontally and deposit it in the following tank. After immersion it is released from the fingers to progress through the tank.

The conveying system also includes two pairs of notched stainless steel tracks on which the upper cross bars of the film carrying hangers rest. Located above the processing tanks these tracks,

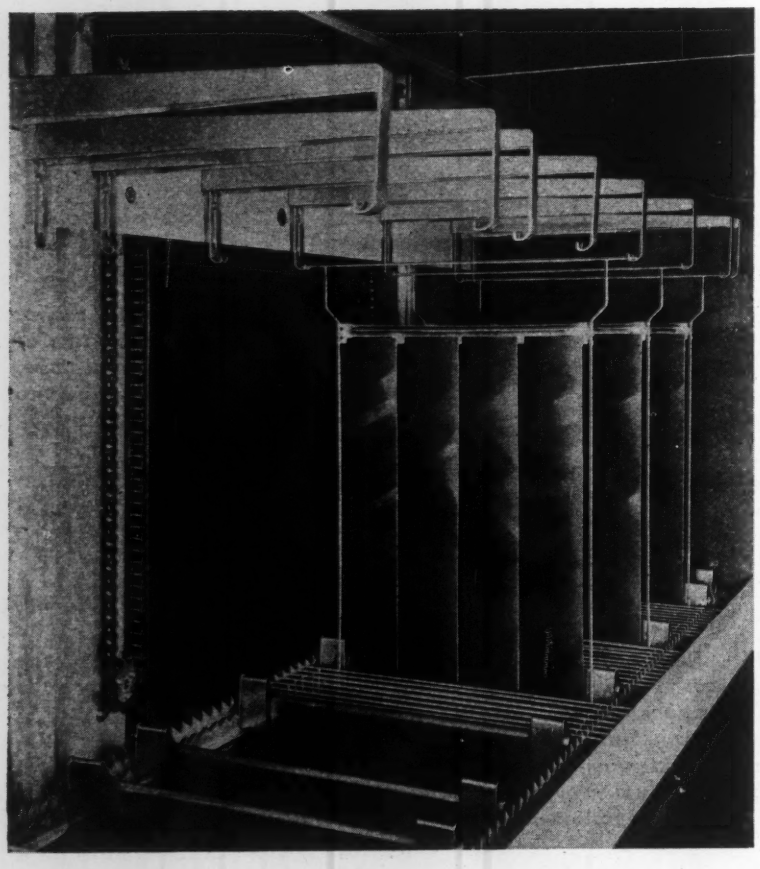


Fig. 1—Left Above—Coordinated conveyors in developing machine transfer film from bath to bath and control variable time in developer

Fig. 2—Left—Transfer elevator and progression track for handling film hangers

Mhanism Employs Differential Drive

shown in *Fig.* 2, move vertically with relation to each other, causing the frames to progress one notch for each cycle of movement. This motion is at a uniform rate and determines the time a film remains in each solution. When the film reaches the discharge end of a tank the hanger in which it is supported is engaged by a pair of the hooked fingers attached to the elevator bar and is tranferred to the next tank for further processing.

Manner in which the hangers are progressed by the notched tracks is illustrated schematically in *Fig.* 3. The end of the rod which appears in this diagram is the top cross rod of a hanger and is the only portion engaged by a conveyor system. The moving tracks are mounted at each end on a common member which raises and lowers through the action of a multiple-lobe cam in a cam box at the rear of the machine. Drive is from a gearbox which also drives the elevator mechanism.

Action of the cam is distributed from the cam follower through push rods and rocker arms to each moving member. The tracks travel slowly up and down, serving to agitate the films in the solutions while the forward motion is taking place. All hangers are thus progressed to the "pick-up" position at the end of the tank.

Because developer-saturated film will fog excessively if exposed to air for over 30 seconds, the time alloted for a complete cycle of the elevator bar is necessarily limited to this period. If a uniform velocity were used throughout the entire path which the elevator bar describes, the horizontal movement occurring at the top of the path would be rapid enough to cause dangerous swinging of the films.

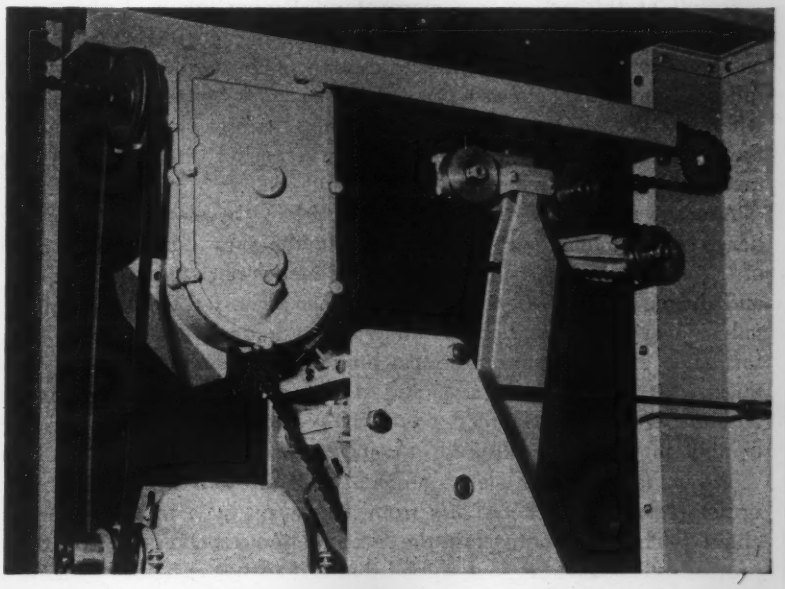


Fig 4—Power unit gearbox and variable-speed chain drive for elevator bar. Cam-controlled idlers provide reduced speed of elevator chains at top of bar travel

Accordingly the mechanism shown in *Fig.* 4 was devised to decrease the velocity at the upper portion of this path. All parts of the conveying mechanism must operate in timed relation and it is imperative that any mechanism used must be incapable of disturbing this relation. *Fig.* 5 is an illustrative diagram showing the action of this differential drive. The two uppermost sprockets drive the vertical chains to which the elevator bar is attached and are the members which must have their speed of rotation varied.

The constant-speed drive sprocket, *Fig.* 5, rotates in a counterclock-wise direction, driving the chain passing over

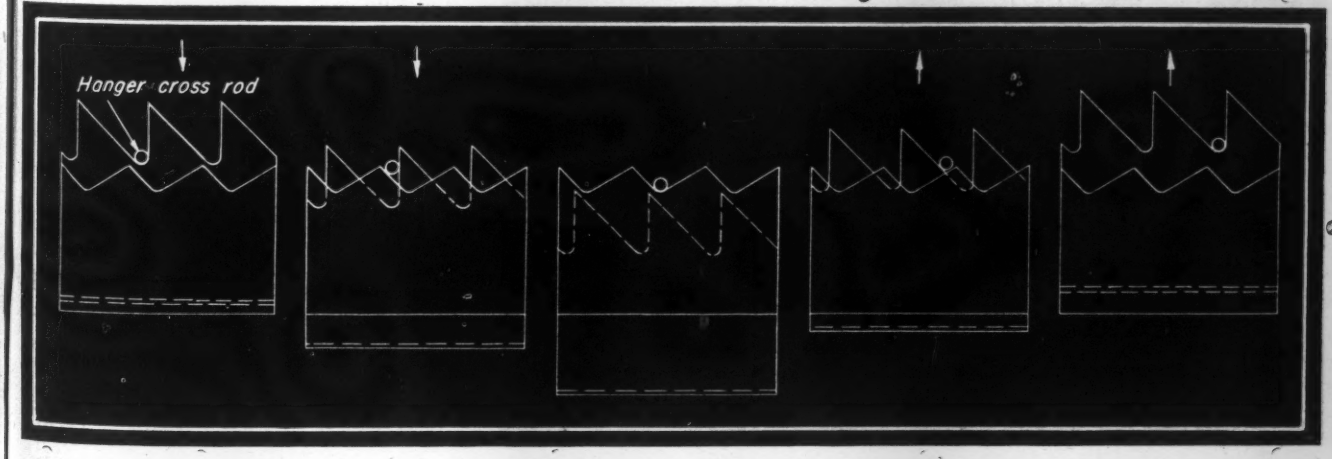


Fig. 3—Operation of progression track. Two notched members, one stationary and the other oscillating vertically, advance the hangers through each tank. At the same time this up-and-down motion provides agitation for proper processing of the film

it in the direction shown at a constant velocity. Variable speed is obtained by passing the chain over one stationary idler and two movable idlers mounted on a base and free to slide on a horizontal bar. The movement of the two idlers is determined by a cam and lever system timed to move the idlers to the left as the elevator bar approaches the top portion of its path. This movement feeds chain into the pulling portion of the drive chain and withdraws a like amount from the idler or nonpulling portion.

Result of this action is a momentary slowing down of the two driven sprockets and the mechanism dependent on them for motion. An opposite motion of the two idler rollers is timed to occur at a point in the elevator bar travel where the acceleration is not objectionable, thereby placing the idlers in position to again provide a period of slow motion.

Average velocity of the chain which drives the elevator bar is 3.025 inches per second. During the slow portion of travel it moves at approximately 1.82 inches per second, and during accelerated travel 4 inches per second. These values were selected because they afford a desired performance and do not represent a limitation of the mechanism. It is possible to stop and start a driven member without disturbing its timed relationship with other units or affecting the time required to complete a cycle.

Power to drive the elevator chains is delivered to the upper elevator sprocket shafts from a gearbox by a roller chain. The cam actuating the acceleration mechanism previously discussed is so designed that it does not vary the duration of the cycle nor destroy the synchronization which the transfer mechanism must maintain with the other functions of the machine. This cam is one of several cams controlling the timing of the machine and will be discussed later. All secured to a single shaft, these cams derive their positive motion from the same gearbox that drives the elevator and the tracks, thus keeping all the driven units in the machine in synchronization.

Duration of developing period is determined by two levers conveniently located on the control panel, only the upper lever being visible in *Fig.* 1. The lower of these two levers controls a pair of landing guides to position the hangers entering the developer tank, placing them in the first, second or third notches of the progression track. This variation in entering position affects the developing period by one-minute steps.

System Has Seven Timed Periods

The upper lever determines which one of a pair of feed-up cams shall cause the moving track in the magazine section to advance a hanger to the position from which it is transferred to the developer tank. One of these cams causes this transfer 30 seconds earlier than the other. Thus, by combinations of settings of these levers, timing from 4.5 to 7 minutes duration is available in 30-second increments.

Manual loading of the magazine shown at the front end of the machine in *Fig.* 1 is accomplished by placing a hanger in a receiver and moving the handle, shown at the side of the machine, to the right. Retaining fingers on the receiver deposit the hanger on the innermost empty tooth or position on the progressive track. Each preceding hanger serves to trip the retaining fingers to deposit the next hanger until each of the ten track teeth in the magazine is loaded. A safety ratchet is incorporated in the magazine to prevent loading while progression is taking place. Brushes are placed on the lower sides of the magazine to prevent the hangers from swinging.

To safeguard personnel, hangers and the machine from injury, the motor driving the gearbox has an overload safety clutch set to carry the normal load of the machine and to release in event of a jam caused by obstructing the transfer mechanism with bent hangers, stirring paddles, etc. Arms on the elevator bar are pivoted to clear such obstructions without interrupting the operation of the machine.

The dryer end of the machine is equipped with a chain conveyor driven by a reduction gear. Heat is supplied by infrared drying units operating at approximately 900 F. Diffusing type reflectors are used so that the heat is not concentrated to a degree dangerous to the film and a fan is employed to distribute the hot air which tends to accumulate at the top of the dryer.

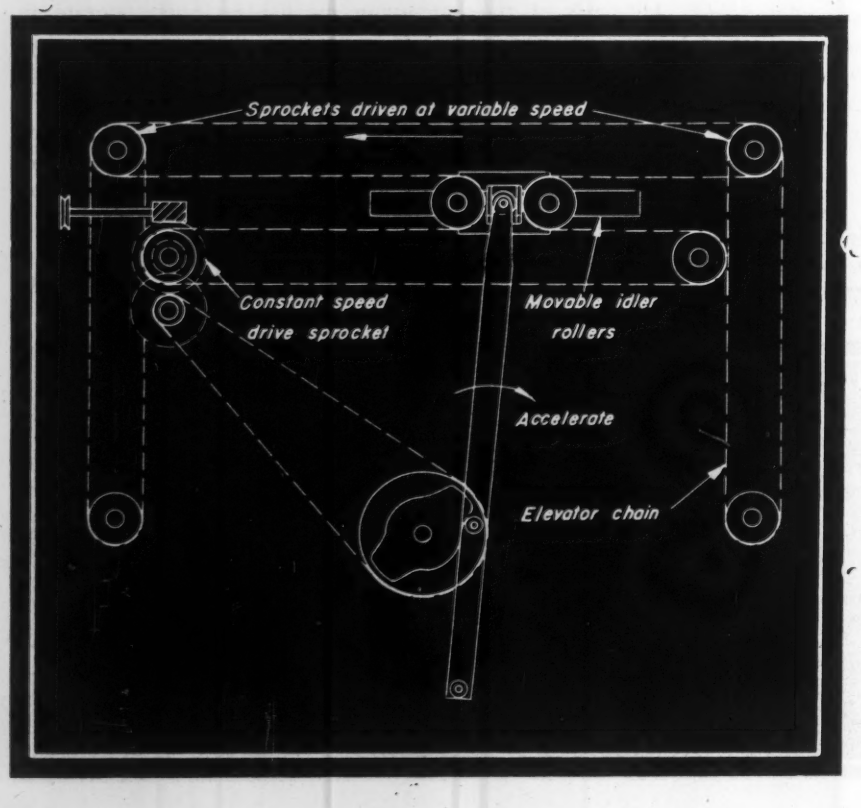
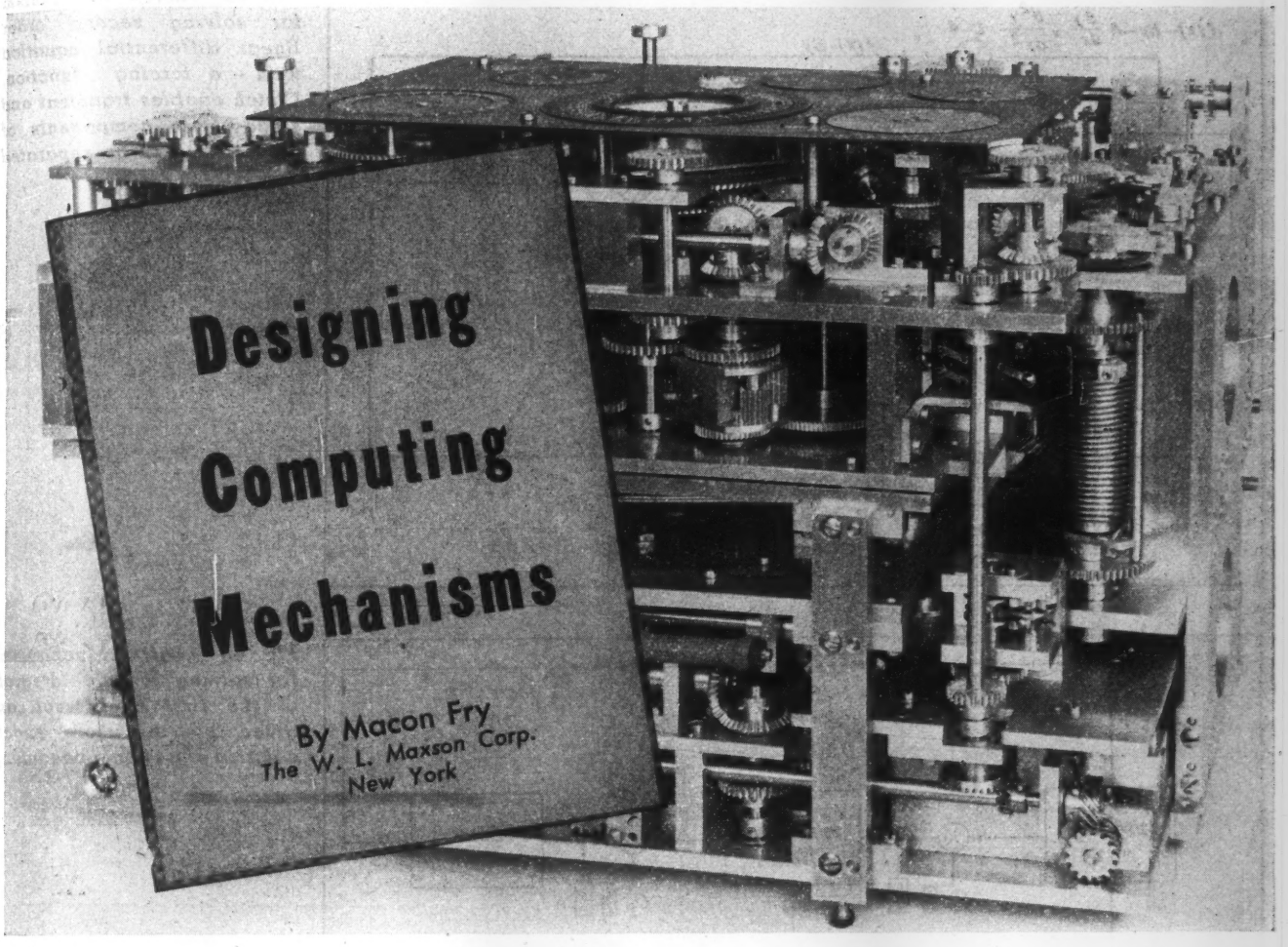


Fig. 5—Schematic diagram of elevator drive showing the speed-varying mechanism for controlling elevator motion



Part V—Differential Equations and Differentiation

MECHANICAL integrators can be combined, in association with other computing equipment, to produce solutions to differential equations. Lord Kelvin (William Thomson) suggested in 1876 a mechanism for solving certain second-order equations[14], and similar apparatus has been constructed by Amsler[15] and Bush[16]. Machines have also been designed for solving the differential equations of motion of a projectile[17]. Indeed, if expense and complexity are no object, it is possible to build a mechanism to solve any differential equation of any form or order.

To demonstrate the method of projecting these devices, the functional schematic diagrams of machines for solving two familiar types of equations are presented herewith. In fact, these functional diagrams can be regarded as a sort of kinematic way of writing the equations. *Fig.* 43 shows the arrangement for solving second-order linear equations of the form:

$$\frac{d^2y}{dx^2}+A\frac{dy}{dx}+By=f(x)$$

This equation can be written:

$$\frac{d^2y}{dx^2}=f(x)-By-A\frac{dy}{dx}$$

which is the sequence followed in the computer. Four counters suitably located indicate simultaneous values of x, d^2y/dx^2, dy/dx, and y. The second differential, d^2y/dx^2, computed as shown later, is integrated with respect to x in integrator No. 1, producing dy/dx. This quantity in turn is integrated with respect to x in integrator No. 2, producing y. The "forcing function", $f(x)$, representing any function of x, is computed by the $f(x)$ computer, which might be of the cam type. The term By is subtracted from $f(x)$ in differential D-3, y having been multiplied by coefficient B in the B-ratio gears. In like manner, $A\ dy/dx$ is subtracted in differential D-4, leaving $f(x)-By-A\ dy/dx$ which, from the last equation, is equal to d^2y/dx^2. This quantity then goes to integrator No. 1, as described. Since the number of arbitrary constants in the solution is equal to the order of the equation, provision must be made for two constants of integration. Handles C_1 and C_2, operating through differentials D-1 and D-2, provide for these constants, corresponding to the initial

14. *Proceedings of the Royal Society* (London) Vol. 24, Pages 269-275.
15. H. de Morin: "Les Appareils d' Integration", 1913.
16. *Journal of the Franklin Institute*, Vol. 212 (1931), No. 4, Pages 447-488.
17. E.g., Maxson Model M-22 Ballistic Trajectory Computer.

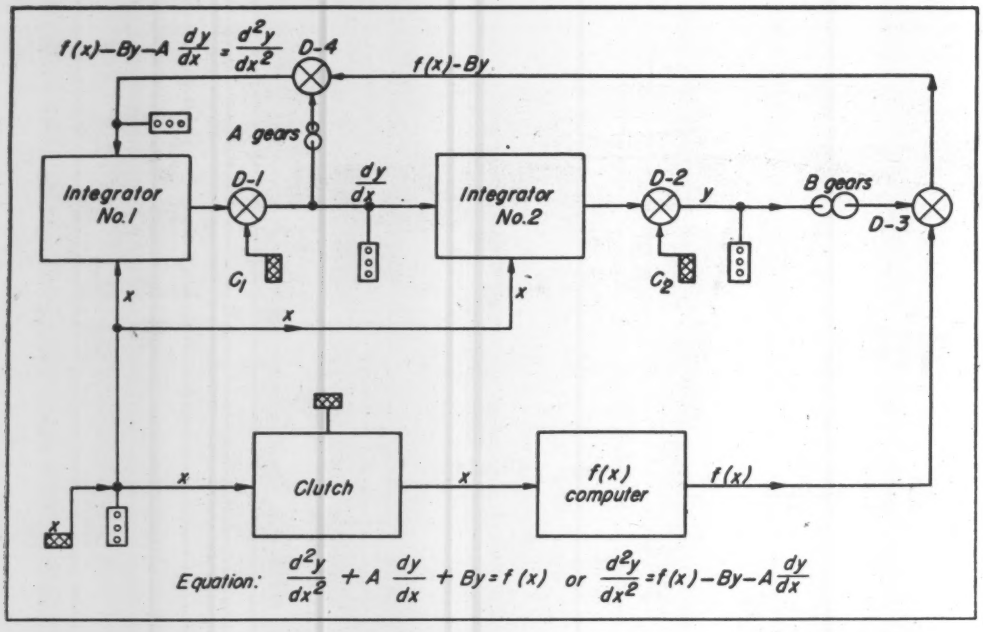


Fig. 43 — Left — Mechanism for solving second order linear differential equation with a forcing function. Clutch enables transient and steady-state components of the solution to be separated

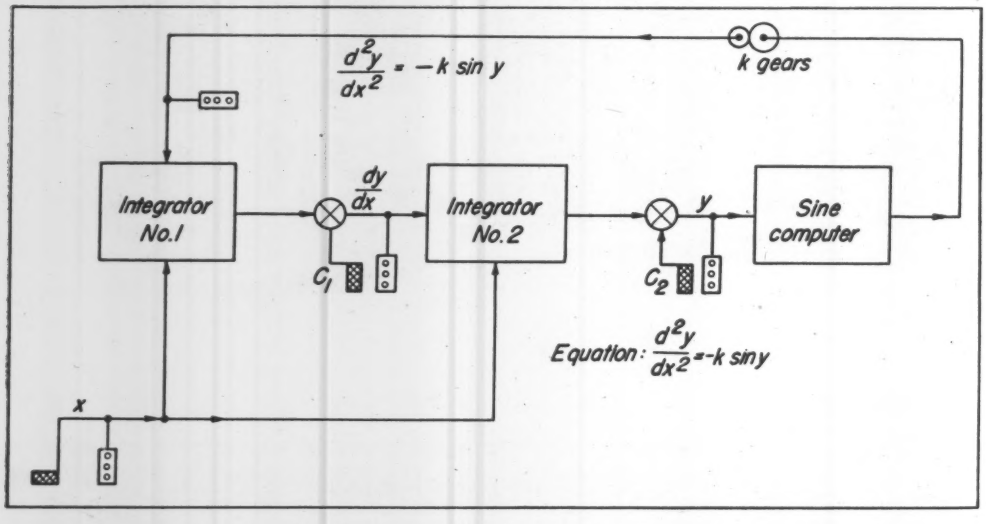


Fig. 44 — Left — Mechanism for solving elliptic integral of the first kind, such as given by the more exact solution of a simple pendulum

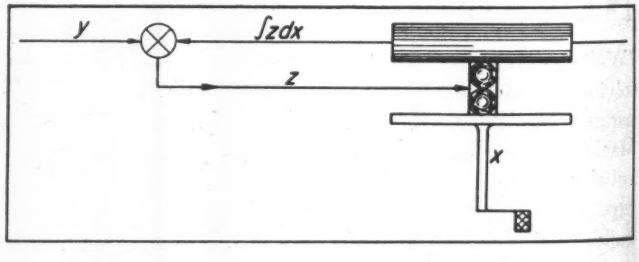
Fig. 45—Below—Method of performing differentiation by means of a ball integrator and a differential

values of dy/dx and y, respectively. The clutch on the x line enables the transient and steady state components of the solution to be separated, if desired. If a repeat run is made with the forcing function held at zero (clutch disengaged), the transient component only will be obtained. This, when subtracted from the complete solution, will leave the steady state, or particular, solution.

Extending the Scope of the Mechanism

Modifications will suggest themselves at once to the designer. For example, ratio gears A and B can be made change gears to take care of different coefficients, or variable-ratio gearing (such as the varigear) could be inserted for greater flexibility; the $f(x)$ computer can have replaceable cams for different functions; the forcing function might be made a function of y (or dy/dx or d^2y/dx^2) if desired; the order can be extended *ad infinitum* by piling up integrators, etc.

In *Fig.* 44 is shown an arrangement for solving an elliptic integral of the first kind, such as a simple pendulum gives rise to. The analysis of this will be left to the reader.



DIFFERENTIATION: In the study of the integrator it was shown that the process of integrating mechanically is exact, provided there is no delay in setting the rate on the mechanism, and the inertia torque is below the slipping point. However, when differentiating there is an inherent theoretical error which alas! cannot altogether be eliminated, although it can be reduced below almost any assigned figure. *Fig.* 45 shows one method of differentiating, where y represents some function which it is desired to differentiate with respect to x. The output of an integrator is subtracted from y in the differential. The output of the differential then operates the ball carriage of the integrator.

If the position of the ball carriage be designated z, then the output of the integrator is $\int z\,dx$, since the incremental input is x. Consequently:

$$z=k(y-\int z\,dx)$$

where k is the scale of z in terms of y and $\int z\,dx$, or,

$$\int z\,dx=y-\frac{1}{k}z$$

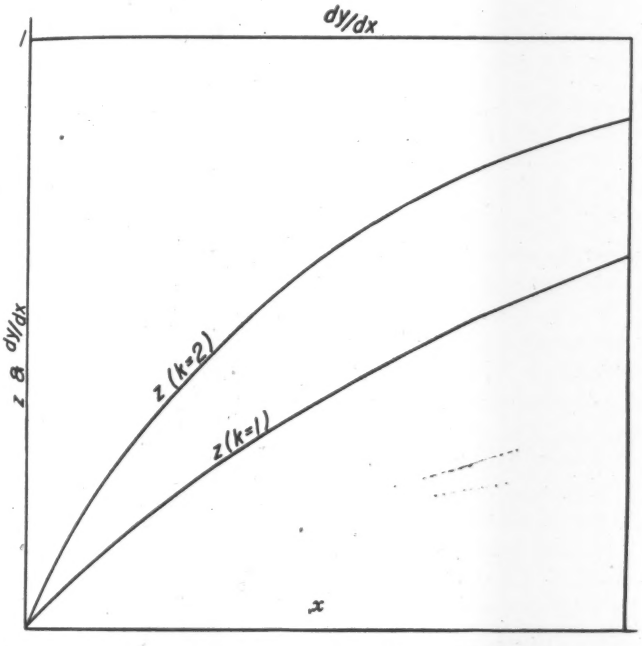


Fig. 46—Above—Response of differentiator to step function. For accuracy the constant k should be large

Fig. 47—Below—Tachometer for ship propeller shaft employs mechanism similar to Fig. 45 except two-disk integrator is used.—Photo, courtesy Pitometer Log Corp.

On differentiating with respect to x, this becomes

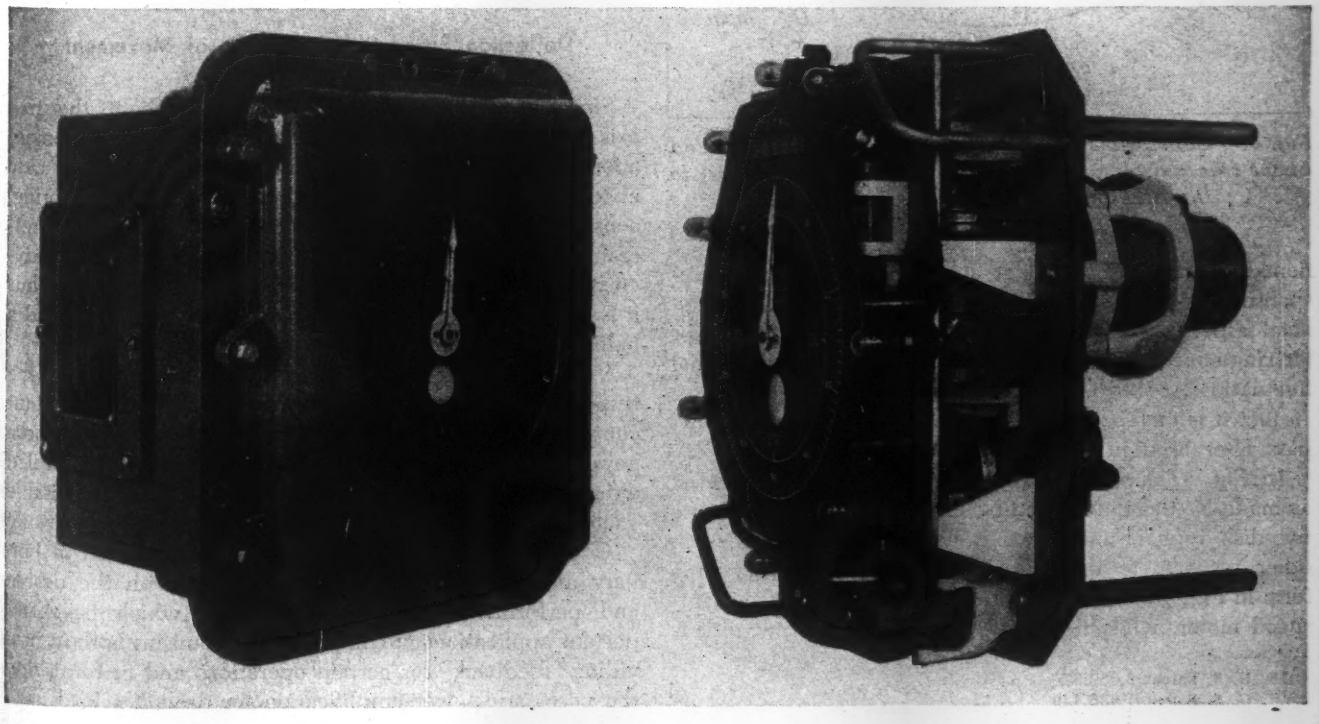
$$z=\frac{dy}{dx}-\frac{1}{k}\frac{dz}{dx}$$

Thus it is seen that z exactly represents dy/dx when, and only when, dz/dx is zero, that is, when the carriage does not move as x is changed. Obviously this can occur only when y is changing at a uniform rate with respect to x (dy/dx constant) and only after a protracted (theoretically infinite) time; or until $\int z\,dx$ is revolving in unison with y, so that the output of the differential is motionless. The action can be realized if dy/dx is taken as a unit step function at $x = 0$, that is, let it be supposed that dy/dx suddenly changes from 0 to 1 at $x = 0$, and remains 1 thereafter. At the start, then, the ball carriage is at the center, and neither y nor $\int z\,dx$ is revolving. Now y begins to revolve at a constant rate and, since $\int z\,dx$ has not yet moved, drives through the differential and begins to move the carriage. This causes the roller to turn, which subtracts from y in the differential and reduces the rate at which the carriage moves outward. Thus the carriage moves more and more slowly as it progresses and the speed of the roller approaches that of the y line. At the end of an infinite time it comes to rest and the roller has the same speed as the y input. The position of the carriage will then represent dy/dz. Analyzing this mathematically:

$$z=\frac{dy}{dx}-\frac{1}{k}\frac{dz}{dx}$$

and since $dy/dx = 1$,

$$z=1-\frac{1}{k}\frac{dz}{dx}$$



which, on transposing, may be written

$$\frac{dz}{dx}+kz=k$$

The solution of this equation is:

$$z=1-Ce^{-kx}$$

and since $z = 0$ when $x = 0$,

$$z=1-e^{-kx}$$

Thus it is seen that k (which is the scale of z) represents the logarithmic decrement of the error in z, and from the standpoint of accuracy it is manifestly desirable to make k as large as possible. *Fig.* 46 shows the approach of z to dy/dx as a function of x for two values of k.

In the majority of applications differentiation is with respect to time, in which case x would represent time and the disk would simply be revolved at constant speed. In this case $1/k$ would represent the *time constant* of the mechanism, or the time required for z to reach 63 percent of its correct value, found by substituting $x = 1/k$ in the last equation. This mechanism has been widely used in this manner as a tachometer for registering the revolutions per minute of a ship's propeller shaft[18]. It might be mentioned that in this particular application the delay in response imposed by the time constant actually has a beneficial aspect, since it produces a sort of "averaging", or filtering effect, and thus strains out periodic and vibrational fluctuations in speed that have no navigational significance. In fact it is mathematically equivalent to the familiar low-pass filter used in electrical work.

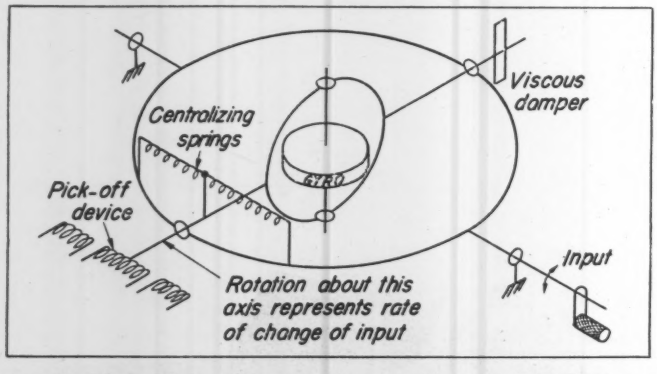


Fig. 48—Constrained gyro tachometer in which deflection about free axis (against linear spring) is proportional to the rate of movement of the input shaft

In *Fig.* 47 is shown the construction of such a device, as made by the Pitometer Log Corp. In this instance the two-disk type of integrator is used, but it is similar in other respects to the differentiator shown in schematic form in *Fig.* 45. The driving disk is rotated by a constant-speed motor, while the shaft carrying the output disk is matched in the differential with the shaft revolutions to be measured. In this instrument, however, the output of this differential does not directly control the radial position of the output disk. Instead, it actuates selective contacts controlling a servomotor, which in turn moves the output disk radially to establish the rate. By using a servomotor, constant k can be large without loading up the input line, thereby increasing the rapidity of transient response. The accuracy of this instrument is stated to be within 1/4 percent of full-scale reading.

18. U. S. Patent 2,089,878.
19. U. S. Patent 1,936,442.

Tachometers as Time Differentiators

OTHER TIME DIFFERENTIATORS: Differentiating any function with respect to time is simply speed measurement, so any tachometer or rate-measuring device is a time differentiator. The familiar fly-ball tachometer is an example. All these devices have inherent errors of one kind or another when measuring varying rates, due to the fact that time is required for the mechanism to "feel" the change and register it. The suitability of a given type for a particular service depends upon the rapidity of its response in comparison with probable changes in the speed to be measured. Some types also involve the use of masses and springs, which gives rise to oscillation as well as ballistic delay. The oscillation must be damped out, which will increase the delay in response.

A time differentiator that has lately come to the fore is the *constrained gyro*[19], *Fig.* 48. The gyro is mounted so that its case, or primary gimbal, has one degree of rotational freedom about an axis perpendicular to the spin axis, its motion about this axis of freedom being opposed by a linear spring. If the case is now forcibly revolved about a third axis perpendicular to both the spin axis and the axis of freedom, the gyro will deflect about the axis of freedom until the torque imposed by the spring is sufficient to produce a rate of precession about the third axis equal to that at which it is actually being constrained to move.

Deflection Proportional to Rate of Movement

Since the spring is linear, deflection about the free axis will thus be proportional to the rate of movement about the constrained axis. Since the inertia of the case about the free axis, together with the opposing spring, constitutes a vibratory system, some form of damping, preferably viscous, must also be present. Magnetic eddy-current dampers have been used for this purpose. Thus it is seen that the response will have both a damping and a ballistic delay.

Various methods are used to "pick off" and apply the response of the gyro about the free axis. An important consideration is that the means employed shall not impose any appreciable additional restraint on the gyro. Coupled alternating-current inductors operating through suitable vacuum-tube amplifiers are often used.

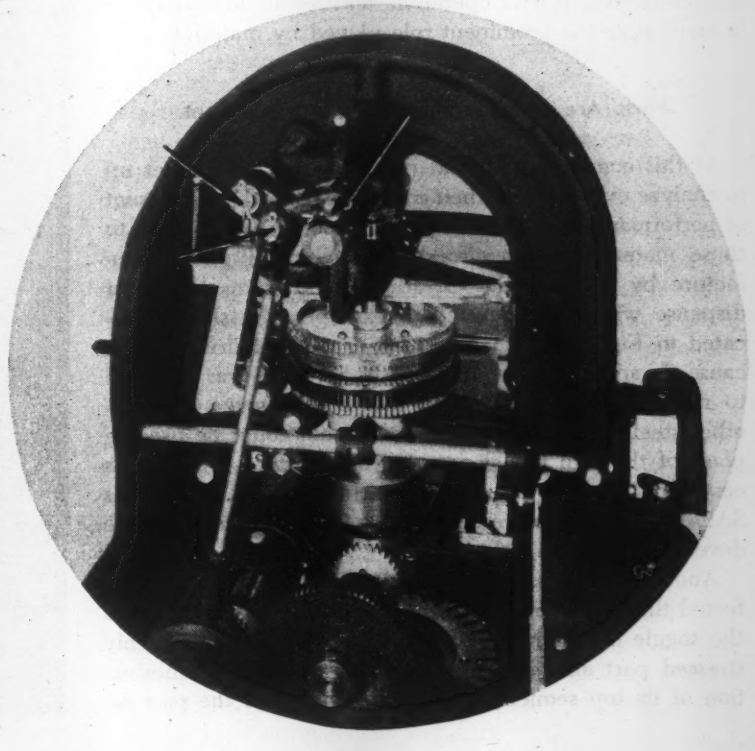
Concluding parts of this series, to be published in January and February, will be concerned with the design and performance of servomechanisms, which have important applications in computing mechanisms both in providing "feedback" for certain operations and in furnishing the necessary power amplification for driving a load.

Fig. 1—Left—Use of different materials for numerous parts of the Graphotype has cut costs and improved performance

Fig. 2 — Below — Rear view of Graphotype. Arrows indicate three shafts formerly made of drill rod, but now made of case-carburized SAE X1112 steel

Redesigning? Consider Materials Changes

By Richard K. Lotz
Associate Editor, Machine Design



WHETHER machines of the future are brand new designs or substantially duplicates of their predecessors incorporating only minor design modifications, careful reappraisal of the materials and production processes used in the manufacture of their parts can, more often than not, result in effective cost savings. Such reappraisal, taking into account the many improved and new materials and production processes developed during the war, may not only reduce manufacturing costs but also serve to improve the machine parts as well.

Some noteworthy improvements have been

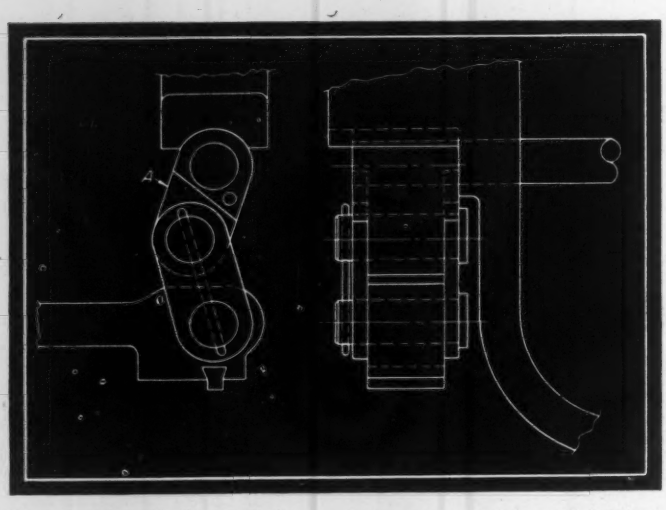


Fig. 3—Toggle link, A, formerly machined from SAE 1120 and heat treated, now is molded of powder iron

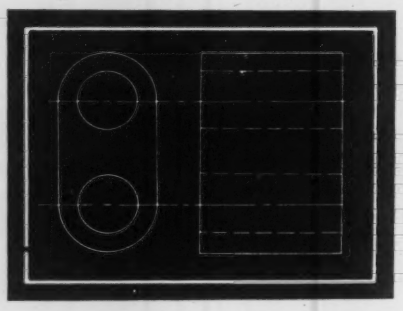


Fig. 4—Left—Toggle link of Fig. 3 after sintering and sizing. Only additional operation required is straddle milling of side cut- outs

made through materials changes in the "Graphotype" (*Fig.* 1), a machine used to emboss letters and numerals in metal plates for the printing of addresses on mailing pieces. The manufacturer of this machine, the Addressograph-Multigraph Co. of Cleveland, being cognizant of pending postwar competition, has launched a research and development program for refinement of the machine. The primary objective of this program is faster performance combined with quieter operation, and results to date serve to emphasize the prominent role played by materials.

Parts Are Analyzed in Special Department

At this company a special department has been set up to analyze every part in their machines from the standpoint of performance and cost. Special attention is accorded to those materials which offer high machinability or manufacture by methods that drastically curtail machining or dispense with it entirely. For example, the shafts indicated in *Fig.* 2 had for years been made of drill rod because, in addition to high strength, hardness was required to resist wear. Investigation showed, however, that another steel, much more easily machined, could be used in place of the drill rod at a saving of one-third in materials cost and 15 to 20 per cent in machining time. This was SAE X1112 and the requisite strength and hardness were developed by case carburizing.

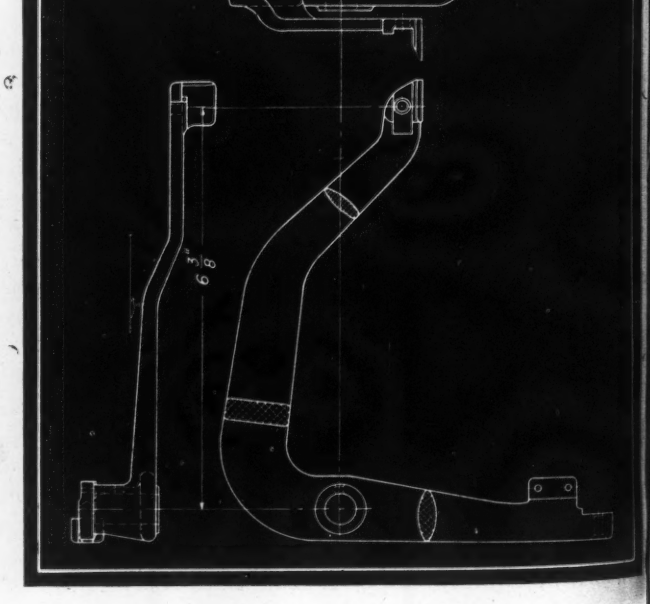
Another good example of cost savings, in this case effected through utilization of one of the newer materials, is the toggle link shown in *Figs.* 3 and 4. This is a highly stressed part and, in addition, requires adequate lubrication of its top semicircular surface which, as the part oscillates, is supported by a machined pocket in the machine frame. While no particular trouble has been experienced in the performance of this part it was expensive to make, requiring considerable machining. After being cut from SAE 1120 rectangular bar stock, its end radii were milled, the two large holes were drilled and reamed in a jig, and then the two side cutouts were straddle milled. A disconcerting aspect of production was the fact that 37½ per cent of the parts were scrapped because the large holes either did not drill and ream to sufficiently accurate parallelism or were distorted out of parallelism in heat treatment.

It now is planned to make this toggle link of oil-impregnated powder iron. The part will be molded complete, lacking only the side cutouts. Holes and end radii are to be sized in a press to a tolerance of plus or minus 0.0005-inch after the part is molded and sintered. With the only machining required being the straddle milling of the side cutouts, cost of this part will be reduced from $2.29 per piece to 81 cents, and this does not include the savings made by elimination of scrap parts. It is interesting to note too, that the part actually will be better because it will be self-lubricating and, as tests have shown, should last indefinitely.

Redesign plus utilization of a different material is exemplified in the case of the trip lever pictured in *Figs.* 5 and 6. This part required light weight plus good strength and as originally designed was a heat-treated aluminum casting (*Fig.* 5). Intricacies in its shape, however, led to foundry difficulties and investigation showed that cost savings and increased strength could be achieved by redesigning the part as a built-up stamping and forming job, the main portion of the lever being sheet steel (*Fig.* 6).

A problem that gave considerable trouble was that of

Fig. 5—Below—Trip lever as cast of heat-treated aluminum. While part functioned satisfactorily, intricacies in its shape caused foundry difficulties.

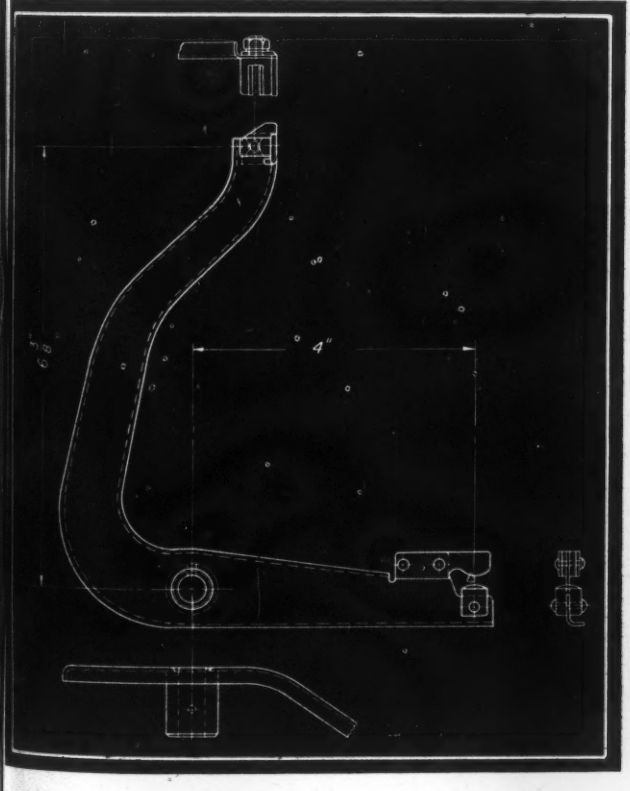


lubricating the bearings of the main shaft of the Graphotype. While the means employed before adoption of the most recent improvement were representative of what ordinarily would be considered good design, in this particular case they were not wholly satisfactory. They involved feeding oil by slinger rings from a common reservoir to heavy-duty bronze bearings. The difficulty experienced was due to the fact that the machines sometimes were tilted at an appreciable angle in transit and this caused the oil in the reservoir to leak out. Thus when set up for operation the heavily loaded bearings soon were forced to run without lubrication and the possibility of failure arose. After many tests conducted with a variety of self-lubricating materials it was ascertained that for this particular application oil-impregnated powder iron bearings stood up best. The savings effected in this case were considerable, amounting to $1.32 per machine, due to the use of fewer parts and reduction of machining time required for the parts involved.

Speedup Effected Through Use of Magnesium

Reference to *Fig.* 7 will bring to attention the ever-expanding field of application for magnesium in fast moving machine parts where low inertia effects are required. The part pictured is the diehead of the Graphotype (see also Fig. 2), and the speed of the machine is dependent to an appreciable degree on the inertia of this assembly. When made of heat-treated aluminum alloy, the central member of the assembly weighed 9 ounces more than an identical part of heat-treated magnesium alloy. It should be pointed out that great strength is not required of this part, its primary function being merely to hold the embossing punches.

Fig. 6—Below—Redesign of trip lever shown in Fig. 5 into unit built up of stamped and formed sheet metal parts not only cut costs but increased strength as well



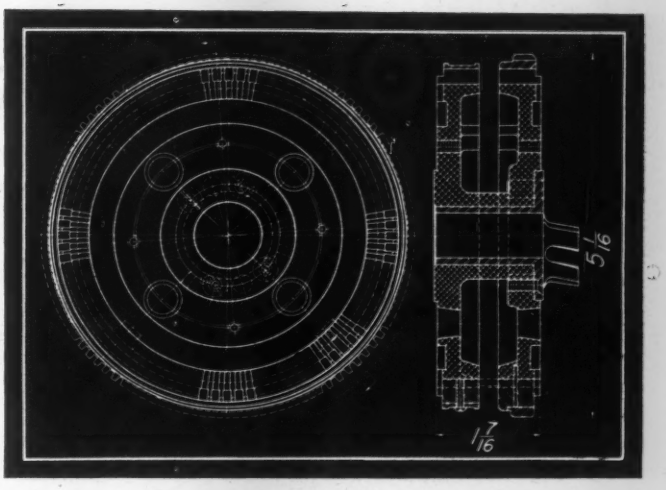


Fig. 7—Above—Diehead of Graphotype, as machined from heat-treated magnesium, weighs 9 ounces less than same part of heat-treated aluminum

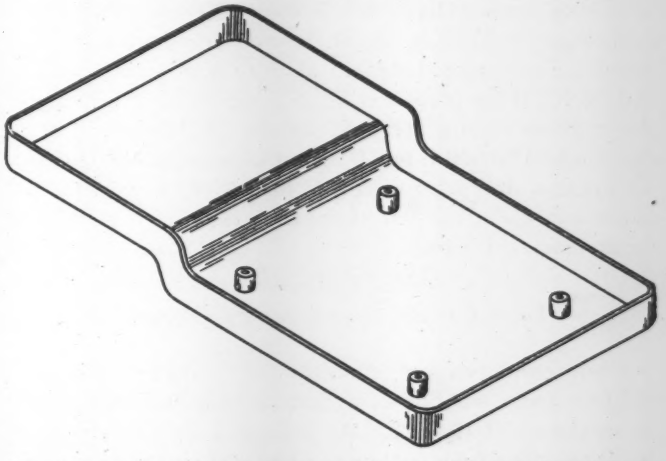


Fig. 8—Above—As formed of sheet steel, this oil drip-pan acted as a sounding board, thus increased the noise level of the machine. Switch to laminated plastic, which offers noise-damping qualities, resulted in quieter machine

Another problem presented in the Graphotype was as simple a thing as an oil drip pan. Inasmuch as the embossing of the metal address plates mentioned in the foregoing is, in effect, a punch-press operation, the rapid embossing accompanied by the abrupt shock of punch-positioning results in a noise level of operation that is somewhat difficult to reduce. The drip pan shown in *Fig.* 8, made of stamped and formed sheet steel, acted as a sounding board, thus aggravating the noise condition. Investigation therefore was directed toward finding a material for this drip pan which would offer noise-damping qualities, and this was found in laminated plastics. Here, as in the case of the toggle link of *Figs.* 3 and 4, the desirable improved characteristics were obtained by the simple expedient of using a different material with no redesign.

These few cases serve to emphasize the benefits in costs, performance and customer satisfaction that may be achieved by careful materials reappraisal. They illustrate, too, why it is imperative for the designer to keep abreast of the improvements continuously being effected in the many engineering materials at his disposal.

Analysis of Rocket Engines

UTILIZATION of rocket propulsion for one of the German interceptor planes— the Me 163*—affords a basis for evaluating the potentialities of this type of power-plant for airborne craft. Hitherto used only for propulsion of missiles or as "assist" units on aircraft at take-off, the rocket engine can be made to develop extremely large thrust in relation to the weight of the unit, although this is done at the expense of high fuel consumption.

The Me 163 employs a liquid-fuel rocket engine consisting of a main jet and an auxiliary cruising jet, together with the necessary pumps and control equipment for supplying the fuels to the combustion chambers associated with each jet. The cruising jet delivers enough thrust—660 lb—to sustain normal flight while the main jet, which can furnish up to 3740 lb thrust, is used for short bursts of speed and accelerated climb. At altitudes between 13,100 and 39,300 ft the plane can attain a top speed of 590 mph, the ultimate ceiling being 52,500 ft. Although the ship can climb to 30,000 ft in 2.6 minutes, the endurance is only 12 minutes and it is therefore necessary to operate the plane as a glider for part of the time in order to stay aloft for an extended period.

Fuels Contain the Necessary Oxygen

Fuels employed are concentrated hydrogen peroxide (H_2O_2) and a solution of hydrazine hydrate ($N_2H_4H_2O$) in methanol (CH_3OH). As indicated by the chemical formulas, these fuels contain the necessary oxygen for combustion as well as carbon and hydrogen so that the rocket engine can operate independently of the atmosphere. In fact, the German engine actually delivers approximately ten per cent more thrust at 40,000 feet than at sea level. However, the plane itself is dependent for its support on aerodynamic action, hence cannot fly outside the atmosphere. To carry the plane beyond the point where lift on the wings can be obtained, the jets would have to deliver a thrust greater than the weight of the plane.

At top speed and maximum thrust the rocket engine in the Me 163 delivers the equivalent of 6920 thrust horsepower yet weighs only 365 pounds. However, in jet propulsion the usual basis for evaluation of performance is specific impulse or thrust in relation to rate of fuel consumption. This figure is about 185 pounds thrust for each pound per second of fuel consumption. From this it is possible to calculate the jet velocity, using the well known principle of mechanics that force equals rate of change of momentum, $F = (w/g)v$. Substituting $F = 185$ lb, $w = 1$ lb per sec, and $g = 32.2$ ft per sec per sec, the jet velocity v is found to be 5980 ft per sec or 4080 mph.

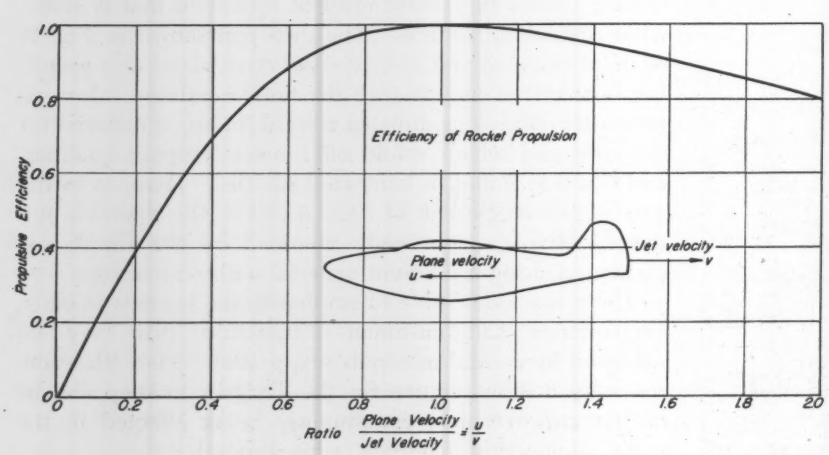
Effect of Speed on Propulsive Efficiency

To calculate the propulsive efficiency it may be assumed that power supplied is equal to the useful thrust horsepower, $thp = Fu/550$, plus the power lost in the slipstream, $lhp = \frac{1}{2}(w/g)\ (v-u)^2/550$, where u is the plane speed. The ratio of thrust horsepower to power supplied is the propulsive efficiency, calculated values of which are shown on the accompanying figure. For plane speed 590 mph and jet speed 4080 mph the ratio is about 0.145 and the corresponding efficiency 0.284 or 28.4 per cent.

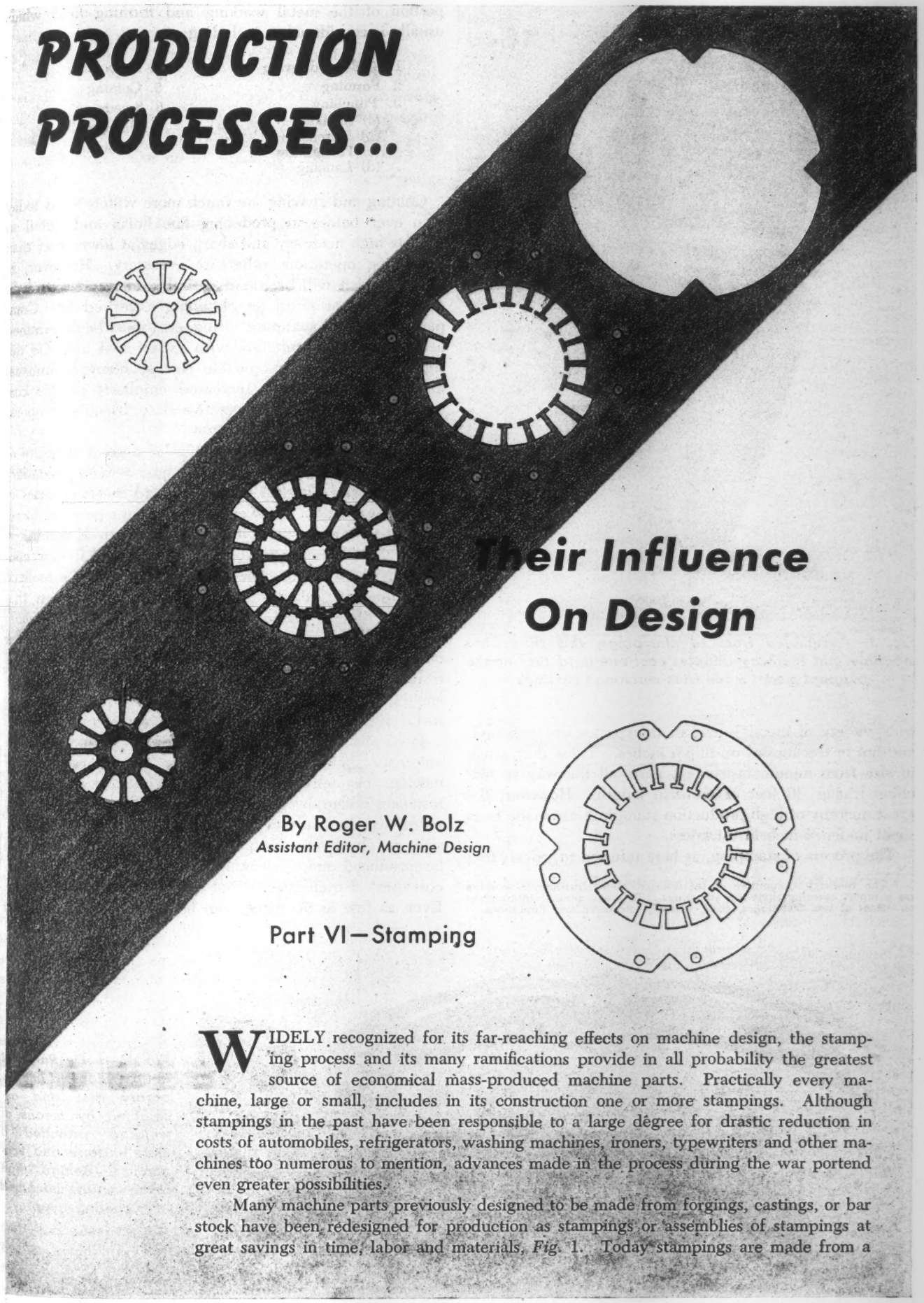
From the foregoing analysis it is evident that reasonably high efficiencies cannot be obtained so long as plane speeds are limited to less than the speed of sound (760 mph at sea level). In considering possible lines of future development of rocket-propelled aircraft, therefore, it would seem that further progress will lie in one or both of two directions. In the first place, it is entirely possible that new airfoil sections capable of sustaining lift with low drag at supersonic speeds will be developed, permitting operation in the stratosphere at speeds of, perhaps, 1500 mph with propulsive efficiencies of over 65 per cent. The alternative is a rocket ship which will travel outside the atmosphere by soaring to tremendous heights in a parabolic arc, after the manner of a projectile. Rocket engines to propel such a ship would have to be capable of delivering a thrust in excess of the ship's weight so as to produce a lift component independently of wing lift, and would consume fuel at a prodigious rate. Some fuel could be conserved by employing more conventional means, such as turbojet engines with lift produced by wings, to accelerate the ship through the atmosphere up to the speed of sound, after which the rocket engine would take over.

Because rocket jet velocities are extremely high due to the powerful fuels that must be used, plane speeds also must be high for good propulsive efficiency.

*"Details of German aircraft, aero engines, jet propulsion units and power boosting systems"—Compiled by the British Air Ministry and released by the U. S. Air Technical Service Command.



PRODUCTION PROCESSES...



Their Influence On Design

By Roger W. Bolz
Assistant Editor, Machine Design

Part VI—Stamping

WIDELY recognized for its far-reaching effects on machine design, the stamping process and its many ramifications provide in all probability the greatest source of economical mass-produced machine parts. Practically every machine, large or small, includes in its construction one or more stampings. Although stampings in the past have been responsible to a large degree for drastic reduction in costs of automobiles, refrigerators, washing machines, ironers, typewriters and other machines too numerous to mention, advances made in the process during the war portend even greater possibilities.

Many machine parts previously designed to be made from forgings, castings, or bar stock have been redesigned for production as stampings or assemblies of stampings at great savings in time, labor and materials, *Fig.* 1. Today stampings are made from a

Fig. 1—Assembled from 14 stampings, this 50-caliber machine gun feedway adapter cost one-third that of the original model made from machined castings

wide variety of metals—cold in thicknesses up to ¾-inch and hot in thicknesses up to 3½ inches. These may range in size from minute instrument parts all the way to machine frames 30 feet or more in length. However, the great majority of high-production stampings are made from sheet under ⅜-inch in thickness.

The process of stamping, as here referred to, covers that portion of the metal working and forming field which usually is considered as including:

1. Shallow drawing
2. Forming
3. Punching
   (a) Blanking
   (b) Piercing
   (c) Perforating
   (d) Lancing
4. Embossing
5. Coining
6. Swedging
7. Shaving
8. Trimming

Coining and shaving are much more widely used today than ever before in producing fine finish and detail as well as high accuracy and sharp edges at lower cost than machining operations otherwise necessary. However, in many cases it will be found desirable to resort to a light machine cut or grind for obtaining a desired fit. Comparative costs of stamping, sizing, etc., must be determined accurately by consultation with expert tool and die designers to assure a reasonable cost economy in unusual and borderline cases. Increased emphasis on low-cost mass production makes imperative close, friendly co-operation to achieve these ends.

Costs involved in the production of a great majority of machine part designs necessarily must remain secondary to quality and physical properties, and in some cases to rate of production. However, cost savings possible in redesigning for stamping with equal or improved conditions are highly desirable. These, as has been shown conclusively by war exigencies, *Fig.* 1, can usually be realized by competent design. Conservative estimates show that per unit time at least three to five times as many pieces can be produced by stamping as compared to various other manufacturing methods for obtaining similar end results. This is primarily due to the fact that stampings leave the machine as essentially, a finished piece—separate surfacing, machining, drilling, etc., being dispensed with.

Generally speaking, the great advantage in plain and automatic stamping is the extremely low cost per piece of machine elements produced in vast quantities. In some instances where design is relatively simple, a few thousand pieces can be made to advantage. Relatively simple designs involving punching, forming and drawing often can be produced most advantageously on "temporary" low-cost dies* if quantities do not exceed 5000 pieces, *Fig.* 2. Even as few as 50 pieces can be produced economically

* The Research Committee of the Pressed Metal Institute is working on a report covering short-run stampings. This will present information on extent of use, techniques, costs, quality, tolerances and limitations.

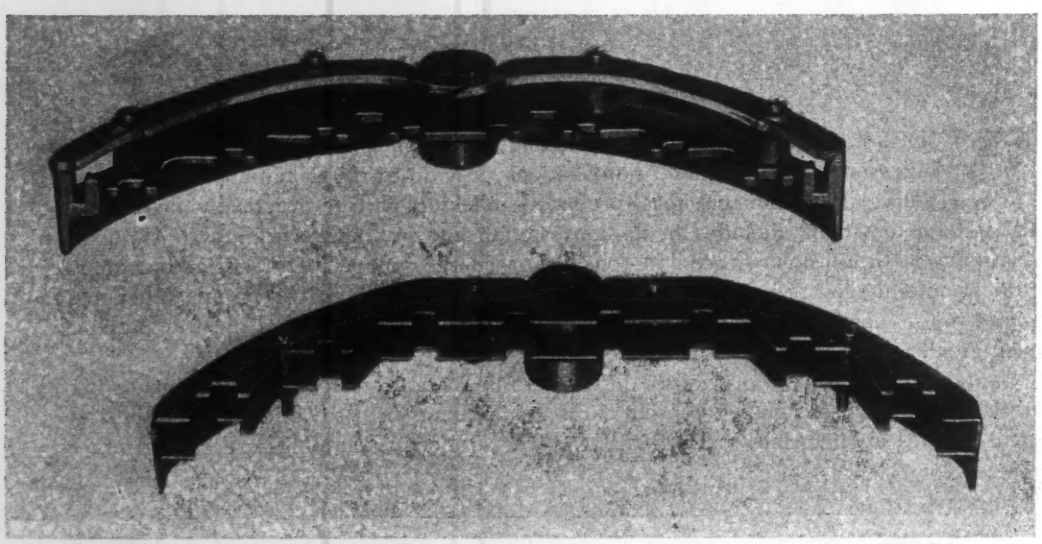


Fig. 2—Left—Parts at bottom blanked in temporary dies and assembled by means of welding provided a more uniform and economical design than those using machined castings, top

by this method. However, if tooling and die costs can be spread over many hundreds of thousands of parts, design can be as complex or intricate as conditions require.

A most essential factor to bear in mind in designing for stamping is that the basic material in the form of sheets is of substantially uniform thickness, and sections can be thinned or bosses raised only with considerable difficulty. Commercial tolerances on rolled sheet make it difficult to draw material lighter than 0.020-inch. Use of heavy plate may be necessary to overcome the lack of vibration damping qualities in light gage stampings.

DESIGN: Although a part can be made as a single stamping or an assembly of stampings, if the number of operations required is excessive the overall cost may be such as to offer no advantage over other production methods. The particular method and machine for producing the stampings must also be considered. Certain forms and shapes necessarily are limited to one type machine to assure economy in production.‡ Simplicity of design within reasonable limitations, however, is essential to secure maximum value from the use of stampings regardless of method, *Fig.* 3. Designs should not follow that of complicated castings with many wall thicknesses and bosses. Costs mount rapidly if bosses, stiffeners, etc., have to be added by welding.

Blank shapes should always be designed with true radii throughout, *Fig.* 4, wherever possible. Rounded corners are as a rule preferable to square ones owing to the greater

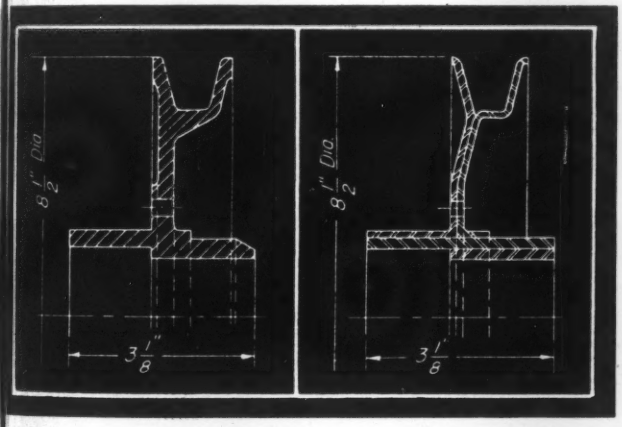


Fig. 3—By means of a combination of simple stamping operations, copper welding and press sizing, all machining is eliminated on this damper hub pulley, right. Weight is reduced by 40 per cent and appearance greatly improved over that of the original casting, left

ease in die sinking. Blanks which can be produced by plain cut-off from a strip, however, can be designed to have square corners if desired. In addition to perfectly square corners on such parts, no scrap is produced from the sides or ends. Square corners can also be produced easily with a sectional die, the type often used when the parts are unusually large or quantities extremely high (possibly a million or more pieces).

In pierced or perforated parts, plain round holes are most economical to produce and should be used in preference to irregularly shaped slots. Perforations—multiple

‡ The Technical Committee of the Pressed Metal Institute is preparing for publication data on formed sheet metal parts and their classification by shape and methods of production.

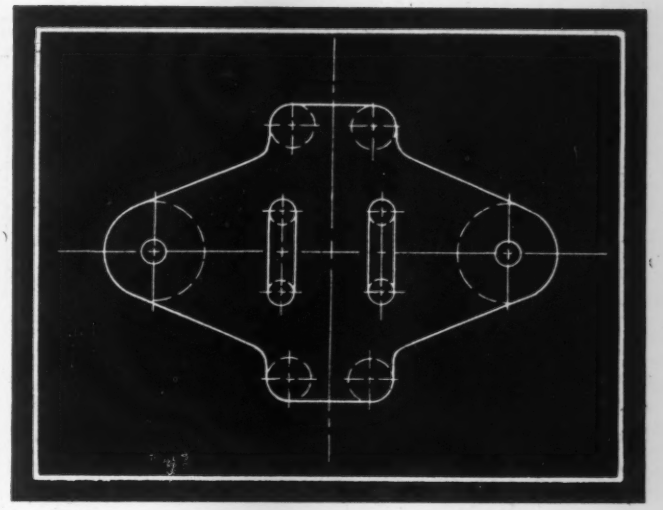
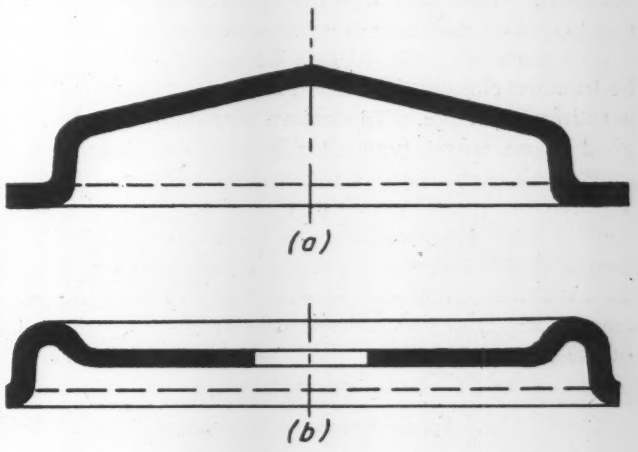


Fig. 4—True radii on blanked parts provide maximum simplicity and lowest die costs

Fig. 5—Below—Trimming is simple for shallow formed parts with flanges (a). Flanges can be trimmed close (b) to give a satisfactory edge and obviate expensive dies



tiny holes—should not be smaller in diameter than the thickness of the material and in any case not under 0.030-inch. Smaller holes can be produced but at considerably increased cost even in ordinary steels. Perforations in high nickel alloys usually are limited to a minimum diameter equal to the sheet thickness for gages down to 5/32-inch. Gages under 5/32-inch must, for economical production, have holes specified greater than the sheet thickness, say at least 1.5 to 2 times. It is likewise inadvisable to attempt to perforate chromium-nickel stainless steels where the hole diameters are less than 1.5 to 2 times the metal thickness. The same is normally true of piercing—holes several times greater than the material thickness or of other shape than round—in which the above limitations are related to the least dimension. Spacing between holes or between the edge of a hole and the edge of the blank should be at least equal to the stock thickness and preferably greater to prevent distortion. Holes should be located as far from bends as is possible to obviate the necessity for an extra operation or a special punch to assure a true hole.

Width of any projection or slot should be at least 3/32-inch or greater for stock under 1/16-inch thick. In heavier material they should be not less than 1.5 times the stock

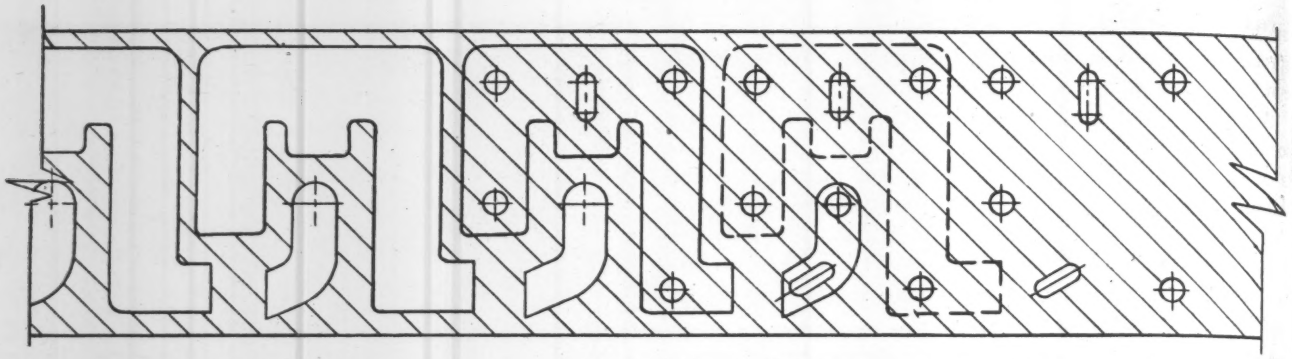


Fig. 6—For economy, parts should be designed to "nest" effectively. Small parts can be made from scrap sections

thickness. Projections should be as short as possible to assure reasonable die life and should be faired into the blank edge with as great a radius on each side as possible.

As a general rule, a round shaped die is the cheapest while tooling for a flanged box with sharp corners is excessively expensive. In designing box shapes with sharp corners, a welded construction will be found preferable and cheaper to tool than a stamped one. However, shallow boxes with generous radii all around—at least ¼-inch to ½-inch—are practical so long as the tolerances on squareness of corners and parallelism of sides are not too stringent. On shallow boxes or covers of large size or unusual contour, trimming is sometimes difficult. As a rule, if such parts are designed as a flanged stamping they can be trimmed close to the sides, *Fig.* 5, most easily and with a satisfactory edge. To achieve streamlined design and good fit on recent typewriter frames, the irregular contours are broken down and annealed before final forming. To maintain proper match of the special flanged sides as well as overall accuracy, these blanks are formed much deeper than necessary and the irregular flange is finished by a multiple trimming operation. In this setup the large amount of scrap encountered was justified by the value of the part itself.

Fig. 7—Below—Sharp inside corners are sometimes a necessity but cause severe stretching of the adjacent material on heavy gage parts

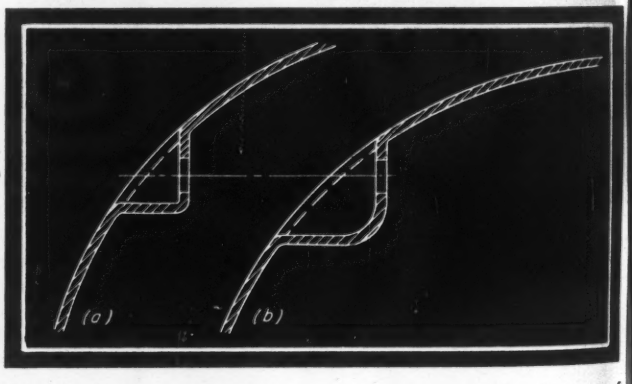


Fig. 8—Generous radii are necessary at the bottom of formed or indented portions (b). Too sharp a radius (a) will cause tearing or breakage of the material

Scrap Economy Important

Reduction of undue waste or scrap material can lower costs effectively by proper consideration during design. Slight changes to secure effective "nesting" of stampings in the strip to be used can minimize waste and often make possible the production of other parts from scrap centers, etc., *Fig.* 6. It is considered good economy if layouts utilize 75 per cent or more of the strip area. Where quantity is sufficiently great, ribs, stiffeners, swedged holes, etc., can be utilized to make feasible and highly economical production of a part from a lighter gage material.

On parts being formed along with a sequence of stamping operations it is often difficult to hold exact right angle bends. This is especially true with the harder materials and heavy gages. Unless slight deviations are allowable, more costly dies must be used. Bends should, if at all possible, be made across the grain or in other words at 90 degrees to the length of the strip to avoid cracking. Where this is not possible, a compromise between 90 degrees and 45 should be used. Inside radii of bends should be equal to the material thickness or preferably greater, *Fig.* 7. Smaller radii tend to weaken the part to some extent and usually require an additional press operation. On formed portions especially, generous radii are essential. Sharp corners will usually cause tearing, *Fig.* 8. High-strength, low-alloy steels require large radii, in many instances as much as four times the material thickness for successful bending and forming. Outside radii are normally considered greater than the inside by the stock thickness.

Bent tabs and formed portions of a blank should be designed so as to be at least 1.5 times the material thickness in height. Tabs shorter than this are exceedingly difficult to produce.

Blank developments for bent or formed parts should be

specified whenever the design is relatively simple and dimensions are not too exacting. However, certain parts require a cut-and-try development to assure an acceptable job, *Fig.* 9. These can be most easily worked out in the plant where unusual metal flow or movements can be seen and taken into account readily before the production blanking die is made.

Fine Pitch Gear Teeth Restricted

Many types of small spur gears for lightly loaded applications can be produced by punching. For accuracy medium hard or annealed carbon steel sheet is employed. Soft steels usually produce undesirable rough edges. Brass or aluminum sheet or strip also can be used. In all cases, however, shaving is necessary and as a rule thickness of gears which can be produced is limited to somewhere around 5/16-inch and at best 3/8-inch. Fine-pitch gear teeth should be restricted to light gage blanks for good die life. Gear diameters should be at least 2 times the center hole diameter to avoid twisting out of shape during punching. Fine teeth and thin sections will often exhibit considerable pull-down on the edges which is sometimes objectionable.

MATERIALS: Although steel, aluminum, brass, and stainless steels are used most widely, practically any material can be stamped. However, economy and ease of production vary with the elongation characteristics of the material. Cold-rolled steel sheet and strip with a carbon content between 0.05 and 0.20 per cent is well adapted for general use. Steel with carbon content ranging over 0.20 per cent becomes increasingly difficult to form and shear. A maximum of 0.35 per cent carbon is usually recognized as the limit for reasonable cold-forming characteristics. Deep drawing steel —steel with less than 0.10 per cent carbon content—of course is the preferred stock, especially where the forming is to be severe. With the best deep drawing steels, manufacturers guarantee successful production only where the forming draw necessitates an elongation of the metal which is less than 33 per cent. Parts requiring more severe forming can often be produced but only with special handling at increased expense.

Steels containing sulphur have undesirable cold-working characteristics. Hard temper low-carbon steel has approximately twice the strength of soft annealed steel but can be cold worked only in small amounts. Steel sheet or strip produced by cold rolling has the best surface finish and drawing characteristics as well as the closest gage accuracy. However, if design is such that satisfactory, economical completion of a part can be had only by utilizing an intermediate annealing process, the high surface quality afforded by using cold-rolled stock is impaired. Consequently there is little to choose between hot or cold-rolled stock on anneal jobs. Cold-rolled material is seldom obtainable in thicknesses over 3/16-inch and at best these heavier gages lack the fine surface finish of the lighter gage stock.

Stainless steel (18-8) is an excellent forming and stamping material. For best forming qualities it must be thoroughly annealed. It can then be worked severely—more so than ordinary steel—at one draw, but requires about double the press power and is somewhat harder on the dies. Ordinarily, stainless in gages over ¼-inch is uneconomical for stampings. Where qualities of stainless steel are desired, however, clad steels can often be used. These are available in both single and double-clad types and have approximately the same cold working characteristics as the steel backing.

Nickel alloys, much like stainless steels, are more difficult to work and require greater press power than ordinary

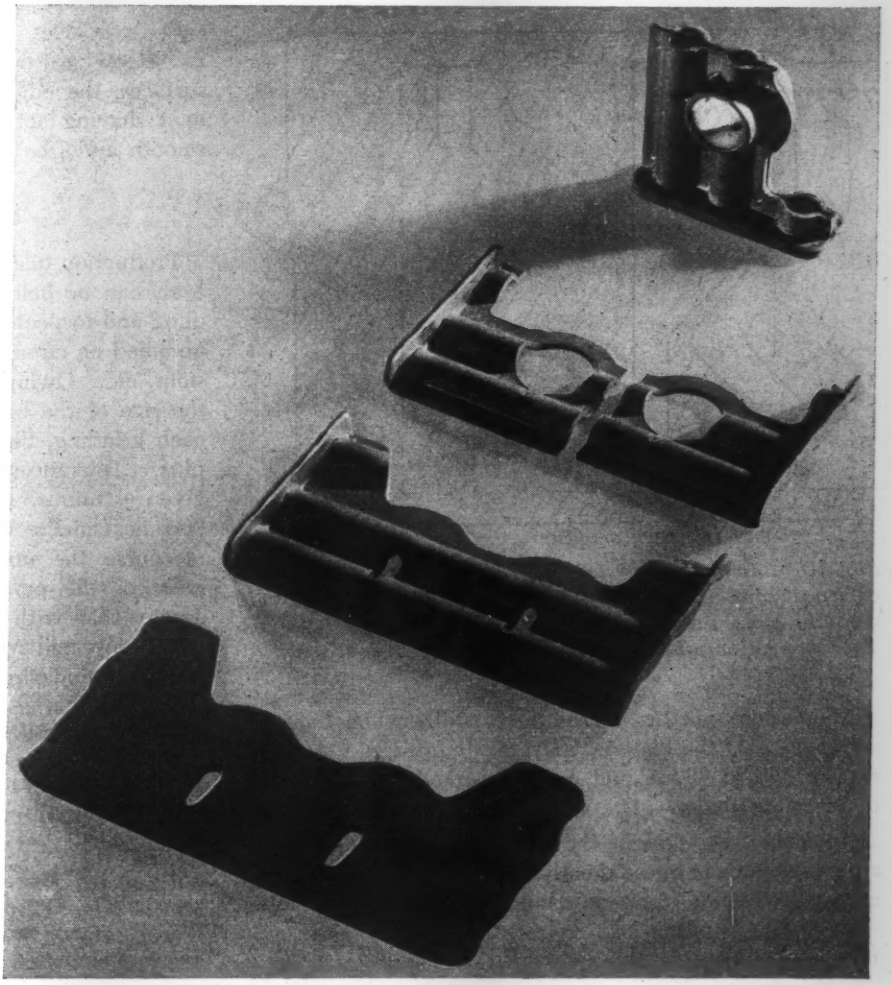


Fig. 9 — Right — Three press operations complete two halves of this rocker shaft bracket. Proper blank development assures a reasonably straight finished edge without an additional trimming operation

mild steels. Depending on the temper, anywhere from 13 to 30 per cent more power is required. Soft to skin-hard temper is preferable for nickel alloy material to be perforated or punched. In punching, dies must be kept sharp as defective edges on holes will usually result in fatigue failures. Punching these alloys results in appreciable work hardening of the hole edges. Consequently, for perforated parts subsequently to be formed or bent severely, annealing is necessary.

Excellent working characteristics of brass and copper alloys combined with good corrosion resistance make them highly satisfactory for stampings. Cartridge brass (deep drawing) is the most satisfactory but tobin bronze, phosphor bronze and other alloys of less ductility can also be used where design requires.

Some Nonferrous Alloys a Problem

Most easily worked of the aluminum alloys are 2S, 3S and 52S (soft tempers). These are preferred where their strength is adequate. The less ductile heat-treatable and age-hardening alloys, 17S, 24S, 53S and 61S, can be used if proper handling can be provided for working them. These are as a rule, worked directly after heat treating before age hardening sets in. For severe forming operations these alloys must be worked in the annealed condition and the parts heat treated later. Age-hardening alloy 61S has better forming characteristics than 53S even though its tensile and yield strengths are higher.

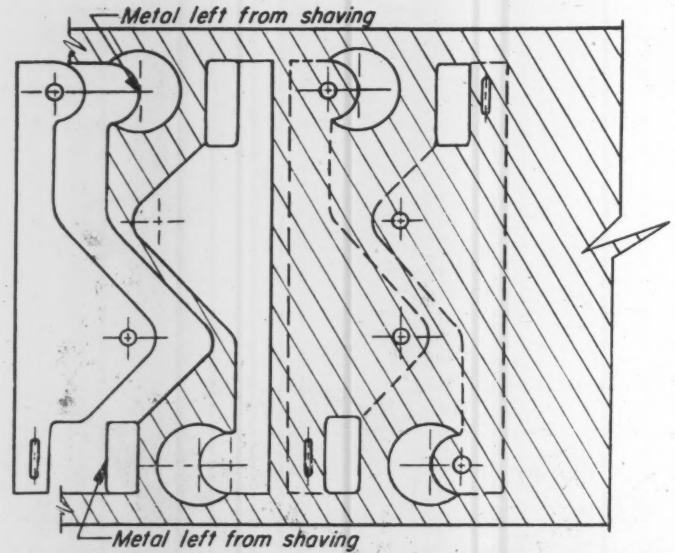


Fig. 10—Removal of certain portions around a part prior to final blanking creates a shaving action to provide smooth, even and accurate edges, eliminating an extra operation which would otherwise be necessary

Magnesium can be worked successfully while hot. As with spinning§ the material must be stamped at a temperature of 450 to 600 F and can be worked severely in this temperature range.

TOLERANCES: One of the most interesting and important developments in the greatly expanded use of stampings in war production has been the achievement of close tolerances and machine-like finish on intricate parts. Coining, sizing and shaving operations make possible and practical accuracies heretofore out of reach. Shaved spur gears normally are held to a total tolerance of 0.001-inch.

Material variations sometimes present difficulties. Parts dimensioned with close edge tolerances usually require complete blanking since slit-edge or edge-rolled stock varies considerably with the gage. Commercial variations in thickness of materials also have their effects on the depth of formed parts. A tolerance of plus or minus 0.010-inch on formed parts under ½-inch in depth and plus or minus 0.015-inch on round parts up to 1½ inches deep can be held. Closer limits require an extra trimming operation.

A hard temper material of course will retain flatness and parallel surfaces more readily than softer ones which pull down at the edges somewhat during blanking, punching, etc. Commercially flat parts—the condition found as parts leave the die—should be accepted wherever possible to obviate extra operations. Surfaces of parts greater than several inches in area which must be flat within 0.002-inch or less will usually require a surface grinding operation. Spring-back on formed parts is usually encountered with hard temper materials and those that work-harden rapidly and necessitate wider tolerances or extra operations to overcome it.

Production is simplified to a great extent if general tolerances can be opened to at least plus or minus 0.010-inch. Often smooth edges and close tolerances are necessary only on a part of a blank. Such cases can be covered by an integral shaving operation, *Fig.* 10, to hold the required accuracy on certain sections at little increase in cost while close tolerances overall would make the cost excessive. By removing a portion of metal adjacent to such specified surfaces, the edges opposite these portions are subjected to a shaving action during blanking, thus leaving them smooth and free from burrs and roughness.

High Accuracy Practical

Production tolerances of plus or minus 0.005-inch, however, can be held where essential, and with careful handling and inspection even plus or minus 0.001-inch can be obtained on circular shapes, hole locations, outside dimensions, etc. Owing to the fact that a blank die determines the size of the blank produced and becomes larger after each grinding, blanking tolerances should be specified as plus. Tolerances on pierced holes, however, should be given as minus. As the punch wears, the hole produced becomes smaller with each grind. With wide tolerances, of course, the number of pieces produced before replacement of the punch or die becomes necessary is much greater than with small tolerances and proper balance between cost and required accuracy must be determined to achieve the maximum benefit in quality and economy.

Collaboration of the following organizations in the preparation of this article is acknowledged with much appreciation:

Aluminum Company of America	Pittsburgh
American Steel & Wire Co.	Cleveland
Dayton Rogers Mfg. Co. (*Fig.* 2 and 7)	Minneapolis
Ford Motor Co.	Detroit
Heintz Mfg. Co. (*Fig.* 1)	St Louis
International Nickel Co., Inc.	New York
Mullins Mfg. Corp. (*Fig.* 3)	Salem, Ohio
Pressed Metal Institute	Cleveland
Toledo Stamping & Mfg Co. (*Fig.* 9)	Toledo, Ohio

§ See part "Part II-Spinning" of this series, MACHINE DESIGN, August, 1945.

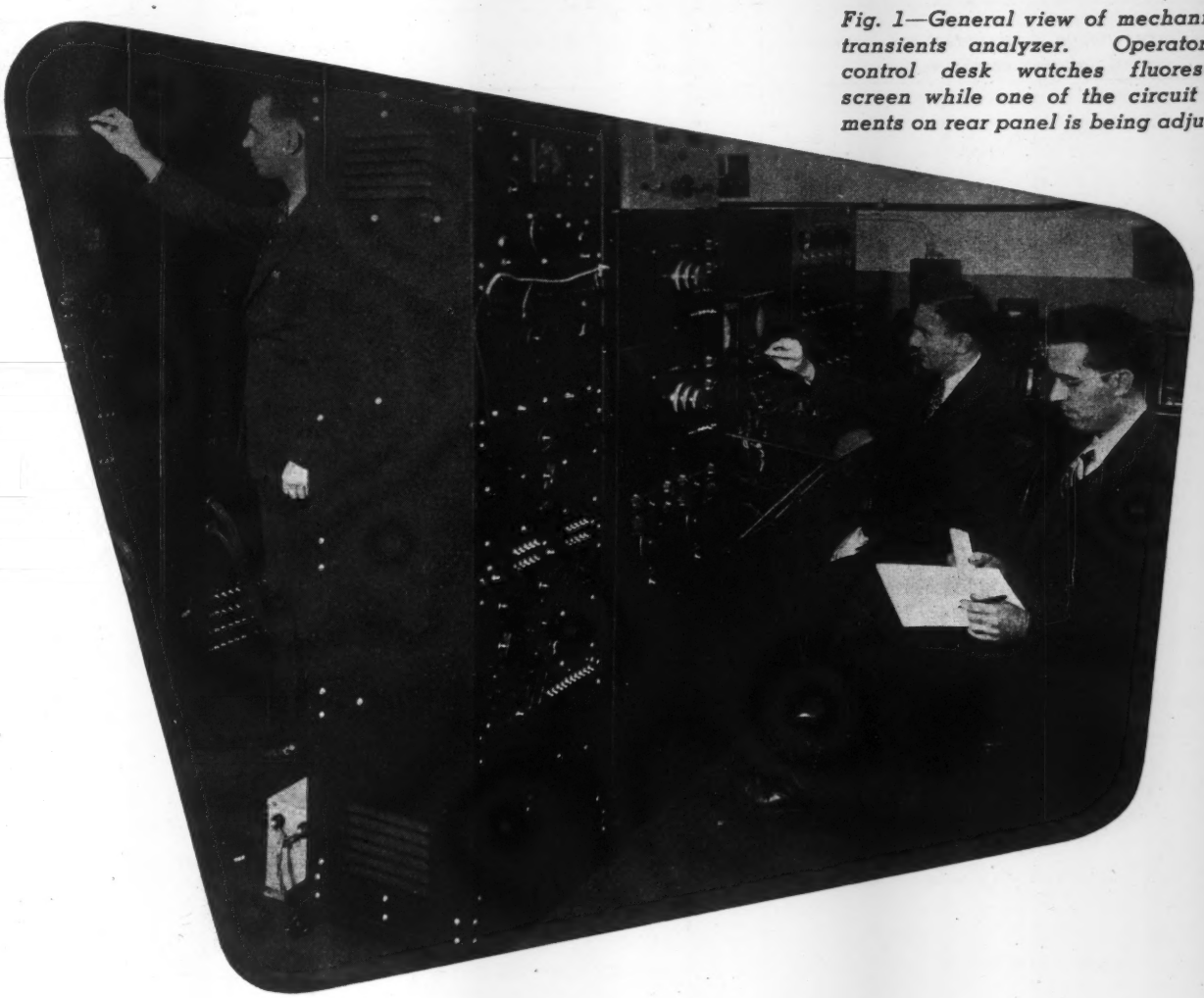


Fig. 1—General view of mechanical-transients analyzer. Operator at control desk watches fluorescent screen while one of the circuit elements on rear panel is being adjusted

Solving Complex Problems by Electrical Analogy

By G. D. McCann and H. E. Criner
Westinghouse Electric Corp.

Part I

COMPLEXITY of man's machines has always exceeded his ability to analyze adequately their performance. As a result, a great deal of machine development has been made possible only through the costly process of building and testing models or through the experience built up from data on actual operation of previous designs. With the accelerating pace of present-day development, it is increasingly important to provide simpler and more complete methods of analysis than are available by conventional mathematics. For this reason, several types of mechanical calculating machines such as the differential analyzer and the network analyzer have been developed.

Through the analogy between electrical circuits and numerous other physical systems, many important and complex problems can be solved with similar electrical circuits. The better-known systems for which an electrical analogy can be set up include mechanical or elastic vibrating systems, systems of the thermal heat flow, and hydraulic systems. Also, combinations of several such interacting systems can be simulated. Simplified lumped-constant

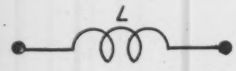
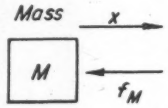
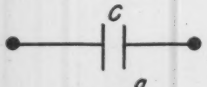
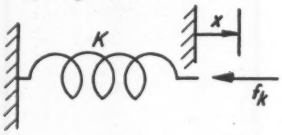
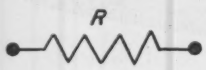
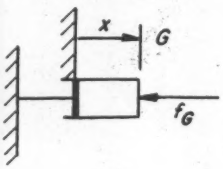
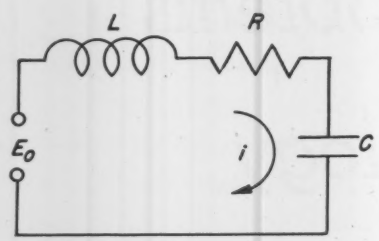
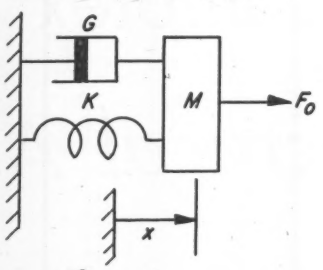
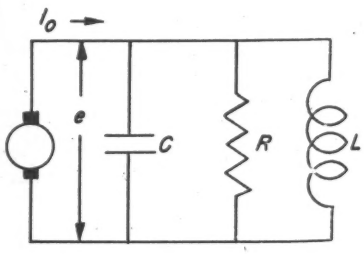
Force-voltage, mass-inductance analogous electric circuit elements		Actual mechanical system	Force-current, mass-capacitance analogous electrical circuit elements	
e = voltage q = charge i = current	$e \equiv f$ $q \equiv x$ $i \equiv v$	force (f) displacement (x) velocity (v) $= \frac{dx}{dt}$ acceleration (a) $= \frac{d^2x}{dt^2}$	$f \equiv i$ $v \equiv e$	i = current e = voltage
Inductance  $e_L = -L\frac{di}{dt} = -L\frac{d^2q}{dt^2}$	$L \equiv M$	Mass  $f_M = -Ma = -M\frac{d^2x}{dt^2}$	$M \equiv C$	Capacitance $i_c = -C\frac{de}{dt}$
Capacitance  $e_C = -\frac{q}{C}$	$\frac{1}{C} \equiv K$	Spring constant  $f_k = -Kx$	$K \equiv \frac{1}{L}$	Inductance $i_L = -\frac{1}{L}\int e\,dt$
Resistance  $e_R = -Ri = -R\frac{dq}{dt}$	$R \equiv G$	Velocity damping  $f_G = -G\frac{dx}{dt} = -Gv$	$G \equiv \frac{1}{R}$	Resistance $i_R = -\frac{1}{R}e$
 $E_0 - L\frac{d^2q}{dt^2} - R\frac{dq}{dt} - \frac{q}{C} = 0$ (By Kirchhoff's second law)		Simple combined system  $F_0 - M\frac{d^2x}{dt^2} - G\frac{dx}{dt} - Kx = 0$ (By Newton's second law)		 $I_0 - C\frac{de}{dt} - \frac{e}{R} - \frac{1}{L}\int e\,dt = 0$ (By Kirchhoff's first law)

Fig. 2—Physical mechanical elements can be represented by either one of two analogous electrical systems

circuits have been developed to represent distributed-constant systems such as long transmission lines for traveling-wave analysis, the propagation of electromagnetic waves, the elastic field, and the flow of electric current and thermal heat through conducting media. It is commonly thought that analogous electrical circuits are confined to problems involving linear-constant coefficient equations. Although this covers a broad field of important problems, the development of nonlinear vacuum-tube circuits permits its expansion into nonlinear fields.

The electrical-analogy method has several distinct and important advantages over the use of models or existing mechanical calculators. It is relatively inexpensive to build suitable circuit elements to represent a wide range of other physical constants. These can readily be put in a form suitable for quick connection to represent a wide range of physical systems. Either steady state or transient solutions can be produced on the screen of a cathode-ray

TABLE I

Conversion Formulas for Circuit Constants

Actual Electric Circuit	Force-Voltage Mass-inductance Circuit
If a is an arbitrary constant and n is the ratio of frequencies in the analogous circuit to those in the actual system:	
$L'=\frac{aL}{n}$	$L'=\frac{aM}{n}$
$C'=\frac{C}{an}$	$C'=\frac{1}{anK}$
$R'=aR$	$R'=aG$
If known excitation function is represented by a voltage E_o', actual voltages or quantities they represent are given by equations:	
$e_n=\frac{E_o}{E_o'}e_n'$	$f_n=\frac{F_o}{E_o'}e_n'$
and currents or their analogies by equations:	
$i_n=\frac{aE_o}{E_o'}i_n'$	$v_n=\frac{aF_o}{E_o'}i_n'$
If known excitation function is represented by current,	
$i_n=\frac{I_o}{I'_o}i_n'$	$v_n=\frac{V_o}{I_o'}i_n'$
$e_n=\frac{I_o}{aI_o'}e_n'$	$f_n=\frac{V_o}{aI_o'}e_n'$

oscilloscope from which all or any desired part (such as a crest magnitude) can be read or recorded.

Developed primarily for solving mechanical vibration problems, the mechanical-transients analyzer shown in *Fig.* 1 is a recent addition to our Network Analyzer laboratory. This machine will be discussed in connection with electrical-mechanical analogies. Since space does not permit a comprehensive treatment of this subject, only a few of the simpler and more fundamental types of systems that can be studied with electrical circuits will be given. These will include mechanical vibration systems with translational motion, rotational motion and combinations of both types of motion. Analogies for combined electrical and mechanical systems will be illustrated, as well as the electrical analogy for thermal heat flow and for hydraulic problems.

ELECTRICAL-MECHANICAL ANALOGIES: There are two possible analogies between physical mechanical elements and electrical circuit elements. These are classified in *Fig.* 2 as the "force-voltage, mass-inductance" circuit and the "force-current mass-capacitance" circuit. For each of these equivalent circuits, numerous analogies can be set up between the mechanical and electrical variables (force, displacement, velocity, and voltage, charge, current). The most useful for each of the circuits are listed in *Fig.* 2, which also illustrates the manner in which a complete analogous electric circuit is formed. For the voltage-force analogy, the circuit is constructed so that Kirchoff's second law produces an equation of the same form as that derived from Newton's Second Law of Motion for the actual mechanical systems.

When the current-force analogy is used, Kirchoff's first law replaces his second law. Equivalent circuits for rotational mechanical systems are set up in the same way except that the rotational mechanical quantities replace the translational ones. Systems involving combinations of both translational and rotational motion will be shown later.

For any practical problem, certain boundary conditions are known or assumed. The boundary conditions involve excitation functions, introduced to one or more parts of the system. These excitation functions may be forces, displacements, velocities, all functions of time or other quantities that cause or start the transient conditions in the problem at hand.

If, in setting up an analogous circuit by the relations of *Fig.* 2, the impedances and analogous excitation functions are made equal to the mechanical quantities in consistent systems of electrical units, electrical solutions will be numerically equal to the true mechanical solutions. However, it is usually desirable to change the electrical circuit constants by a fixed ratio so that it will not be necessary to provide an excessively wide range of variation in the calculating device. Frequently it is also desired to change the time base for the same reason or so that the solution can be recorded more readily. A consistent set of conversion formulas for accomplishing this is given in TABLE I. In practice it is usually more convenient to set the electrical variable representing the known excitation function at an arbitrary value and record the solutions as ratios of this by the equations of TABLE I.

MECHANICAL-TRANSIENTS ANALYZER: The mechanical-transients analyzer (*Figs.* 1 and 3) consists of a form of

Fig. 3—Close-up of fluorescent screens on mechanical-transients analyzer

calculating board containing special low-loss electrical circuit elements capable of representing practical low-loss mechanical systems. In addition, special circuits have been developed to introduce a wide range and large number of excitation functions in the form of either transient or steady-state voltages or currents to represent the known forces, displacements or velocities. For transient problems, synchronous rotating switches are employed to apply the various excitation functions periodically to the analogous electrical system so as to produce a standing wave representing the solution on the screen of a cathode-ray oscilloscope. During a short period between each application, additional synchronous switches short out the various capacitors in the mechanical circuit, thereby removing the energy from these circuits and placing them at rest for the succeeding application of the excitation function. A typical analyzer excitation circuit is illustrated by the following example.

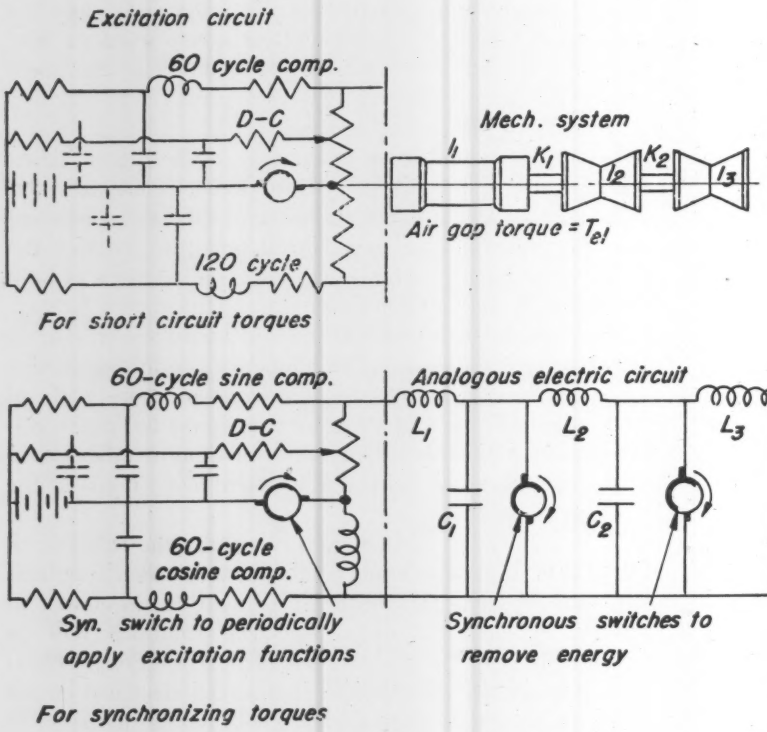
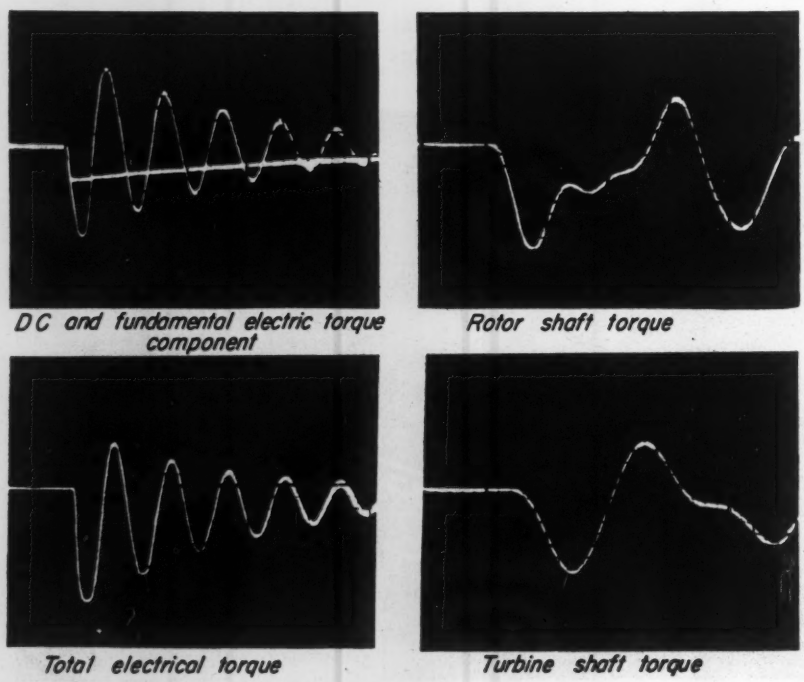


Fig. 4—Above—Turbogenerator system and its electrical analogue, right. Circuits at left represent two possible electrical load conditions

Fig. 5—Below—Oscillographs of the equivalent of a short circuit, left, and the resultant shaft torques, right, for the system in Fig. 4



Analogies for Turbogenerators

TRANSIENT SHAFT TORQUES IN TURBOGENERATORS: In modern high-speed turbine-generators, a knowledge of the shaft torques that can be set up by various types of short circuit or out-of-phase synchronization is important to the design and operation of a unit. For this type of problem the known excitation function is the rotor air-gap torque resulting from the particular disturbance. This consists of a combination of damped unidirectional and oscillatory components at fundamental and harmonic frequencies. A schematic diagram of the transients analyzer excitation circuits used for this type of problem is shown in *Fig.* 4, illustrating the determination of transient shaft torques in a turbogenerator resulting from a three-phase short-circuit at no load. The mechanical system and its analogous mass-inductance circuit are shown to the right of the figure. The air-gap torque developed by the short circuit consists of a damped sinusoidal oscillation at fundamental electrical frequency and a damped unidirectional component, as shown by the oscillograms in *Fig.* 5. Since in this case the force-voltage analogy is used, a voltage proportional to the air-gap torque is impressed on the analogous electrical circuit by means of the excitation circuits previously described. The resulting transient voltages across capacitors C_1 and C_2 are proportional to the rotor and turbine-shaft torque, respectively, and are shown in the oscillograms, *Fig.* 5.

SALIENT-POLE GENERATOR WITH GEARED-TURBINE DRIVE: *Fig.* 6 illustrates a more complicated mechanical system in which it is likewise desired to determine the shaft torques resulting from a three-phase short-circuit at no load on one of two generators driven by a geared turbine.

As shown by the analogous circuits of *Fig.* 6, a gear is represented by a transformer which, in the case of the force-voltage analogy (*Fig.* 2), steps up the current in the direction of in-

creased speed and steps down the voltage in the same direction to represent the corresponding decrease in torque. However, just as in power-system problems, the ideal transformer can be removed by referring all constants and variables to one of the velocities. The generator in this problem has salient poles and the air-gap torque resulting from the short-circuit consists of a damped unidirectional component, and a series of damped sinusoidal components at fundamental and harmonic electrical frequencies. The total electrical torque and the resulting transient torque on each of the three shafts are shown in *Fig.* 7. It is obvious that the analytical solution of this problem would be difficult, to say the least. In addition to shaft torques, it is also possible to obtain data on maximum stresses in the gear teeth and, by measuring velocities, an estimate of impact forces on the gear teeth during torque reversal.

MECHANICAL VIBRATIONS IN ELECTRONIC TUBES: In the mechanical design of electronic tubes, it is necessary to construct the various elements so that mechanical failure will not result from the shocks or vibrations to which a device employing such tubes may be subjected. Because of the relatively small size and flexibility of each element, compared to the mechanical characteristic of the device on which it is usually worked, it will not influence the motion of the main system or other elements. The simplified mechanical system is shown in *Fig.* 8 and is representative of a wide class of applications. The Bell Laboratories were interested in obtaining the general solution for the motion and stresses that would be set up in the tube element of this system when the whole system is dropped to the floor. This is typical of the more severe types of shock to which tubes may be subjected, particularly when in shipment.

Cuts Time to Less than Four Per Cent

The solution to this problem involves determining the maximum deflection of the element in relation to the velocity at impact for a wide range of ratios between the natural frequencies and the damping in the two parts of the system. The general solution therefore requires several hundred values of the maximum displacement of the element relative to the chassis (or box) to enable plotting the solution as a set of curves. Any one of these solutions could be solved in a matter of a few days. However, the complete solution would require more than a year without the transients analyzer. On the analyzer it was completed in less than two weeks. This problem is typical of many which are not too complex for limited analysis but would require a prohibitive length of time to obtain a comprehensive solution by any other

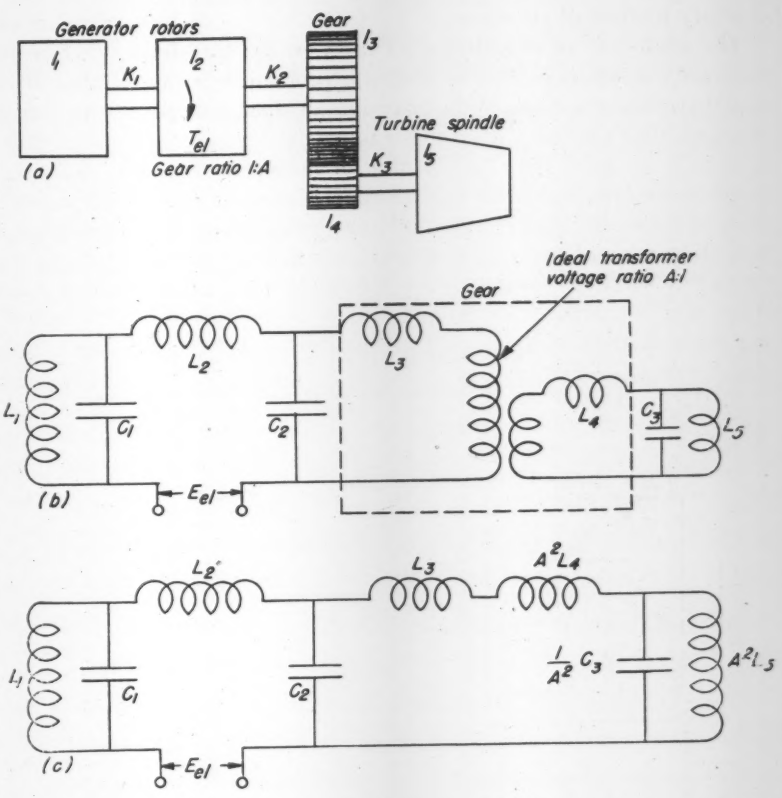
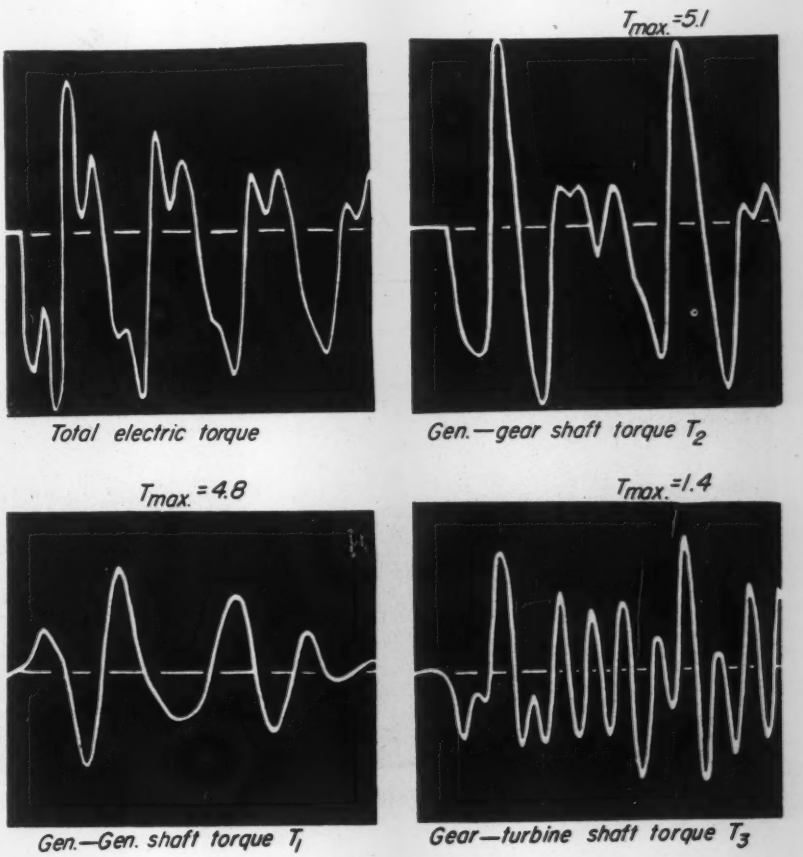


Fig. 6—Above—In geared-turbine system (a), the gear can be represented by a transformer as in circuit (b). A simpler circuit (c) can be used if all constants and variables are referred to one speed

Fig. 7—Below—Oscillographs for the geared-turbine system of Fig. 6 showing the result of a three-phase short circuit



ordinary method of solution.

The analogous electrical circuits used on the transients analyzer are shown in *Fig.* 8. For this problem it is practical to assume that the large mass system does not leave the floor after contact. Also, the mass of the tube element is usually so small that the reaction of its system on the larger mass system can be neglected. In addition, gravitational forces are ignored. It should be pointed out, however, that none of these assumptions are necessary for obtaining a solution by means of the transients analyzer. Also, similar solutions for more complex systems containing more degrees of freedom can readily be solved with this device.

In the analogous electrical circuit of *Fig.* 8, the mass-inductance, force-voltage analogy is used. At the instant before impact, the system is falling with a given velocity $dx_2/dt = v$. This is represented in the analogy by having Switch 1 closed with a steady current i_2 flowing through the coils representing the mass M_2. Since no voltage is produced across R_2 and C_2, the spring is not displaced and no damping forces exist. The condition representing impact is simulated by opening Switch 1 which forces the initial current or velocity through R_2 and C_2, after which the system oscillates freely. The complete transient solution in the form of an oscillogram is obtained on the screen of a cathode-ray oscillograph by having this operation of closing and opening Switch 1 cyclically imposed by the synchronous rotating switch. This produces a standing wave on the oscillograph. The other two rotating switches shown in *Fig.* 8 are simply for the purpose of damping the oscillations out of the circuit in the intervening period so that the system is at rest at the beginning of each cycle. Thus the switches are open-circuited during the period in which the solution is being obtained and shorted in the intervening period. This is only necessary when the circuits contain low loss. *Fig.* 9 shows typical oscillograms of the complete solutions as obtained with the mechanical-transients analyzer.

In the concluding portion of this article, which will be published next month, further examples of the application of the transients analyzer to the solution of mechanical problems will be discussed. These will include the riddability of a vehicle, electromechanical systems such as a separately excited d-c motor drive to a mechanical system, heat flow, and hydraulic problems.

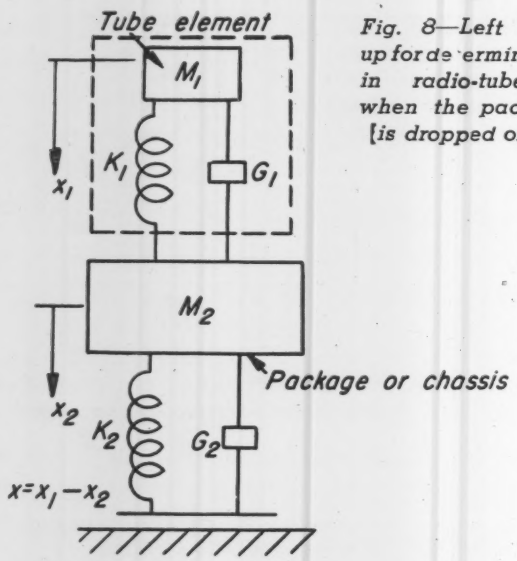


Fig. 8—Left Below—Set-up for determining stresses in radio-tube elements when the packaged tube is dropped on the floor

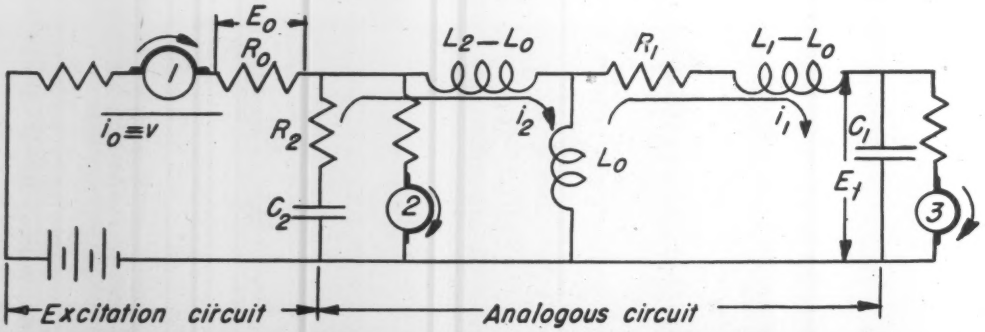
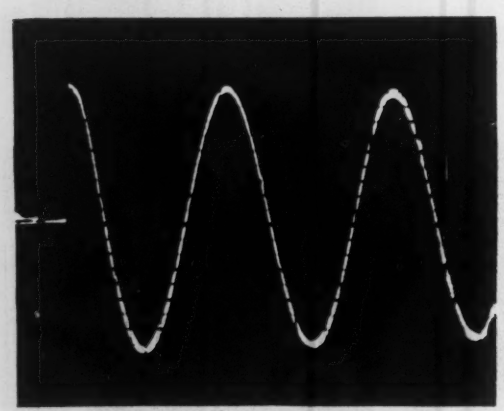
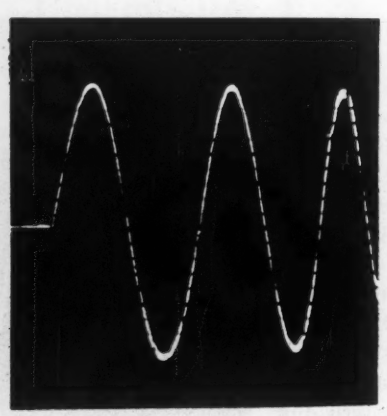


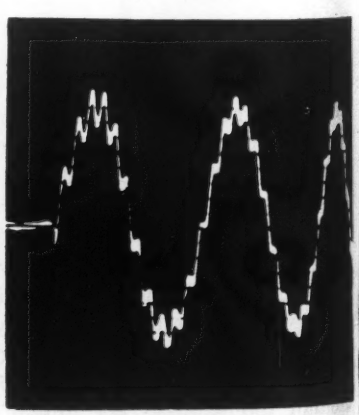
Fig. 9 — Below — Oscillographs for the system shown in Fig. 8, obtained by means of the mechanical-transients analyzer



Vel. (X_2) of large mass M_2



Accel. (X_2) of large mass M_2



Displ. (X) of small mass relative to large mass

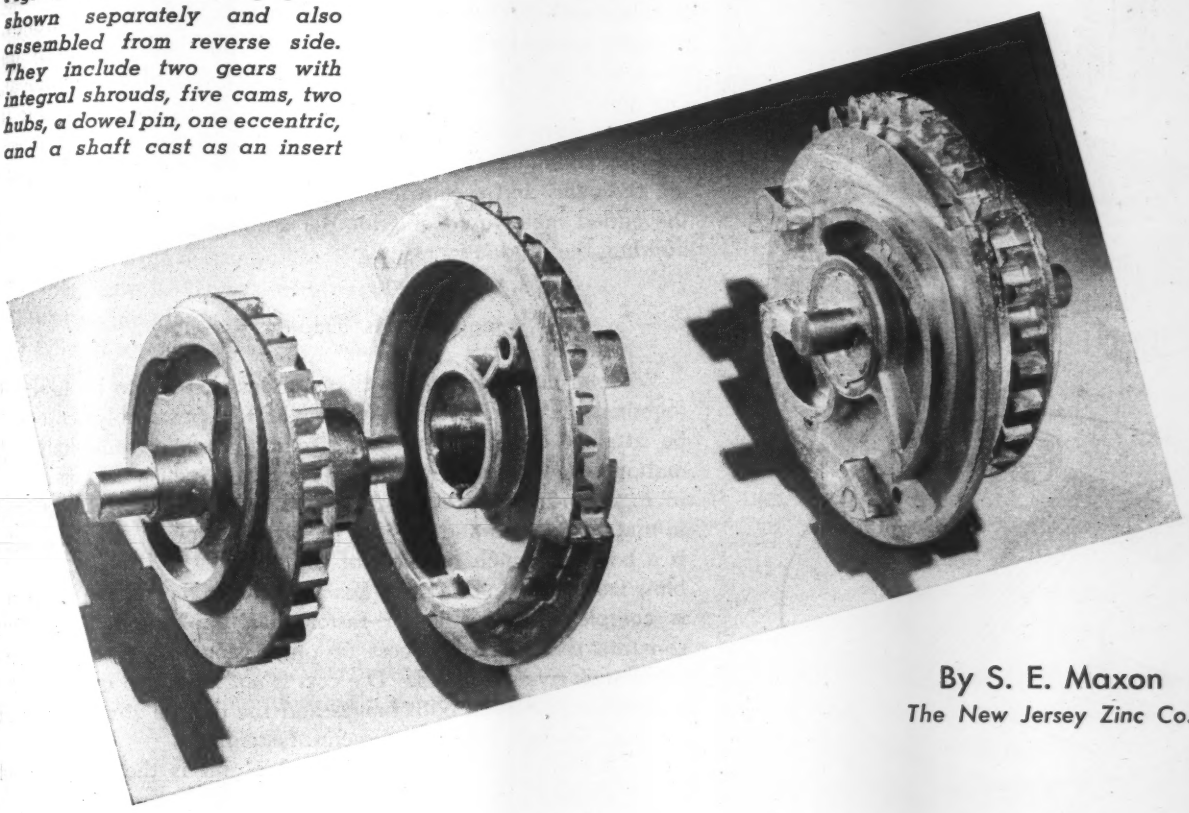


Fig. 1—Pair of mating parts shown separately and also assembled from reverse side. They include two gears with integral shrouds, five cams, two hubs, a dowel pin, one eccentric, and a shaft cast as an insert

By S. E. Maxon
The New Jersey Zinc Co.

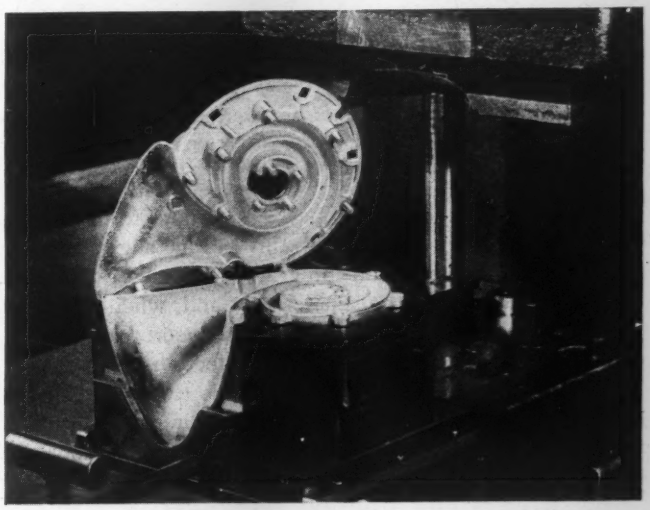
How To Effect Economy with Die Castings

MANY useful "tricks" may be employed in designing die castings. Since some of the more useful expedients often are overlooked, these will be discussed for reference when new designs are being developed. Because every separate part in an assembly adds something to its cost, it is imperative to combine parts into single units wherever possible. Frequently a dowel, key, cam, hub, eccentric, shaft, gear, fastener or other element can be cast integrally instead of being made in separate pieces.

The pair of mating parts, *Fig.* 1, shows how two die castings, one having a steel shaft cast as an insert, can be designed to incorporate five cams, two gears, two shrouds, two hubs (one with an integral key and one with a mating keyway) a dowel pin, and an eccentric. One part has five holes cored to size for mating elements that are pressed or screwed into place. The only machining needed, except for flash removal and tapping is cutting off and knurling the steel shaft insert. This assembly is made inexpensively, yet with dimensions held extremely close. Without die casting, such an assembly would require numerous separate parts and would be considerably higher in cost.

The hub of the smaller casting in this assembly is cast to make, without machining, a press fit in the center hole of the larger part. To insure assembly in correct angular relation, two expedients are used: A key is cast integrally

Fig. 2 — Below — Thirteen integrally cast rivets are headed simultaneously by punches in the fixture shown when the press ram strikes a single blow



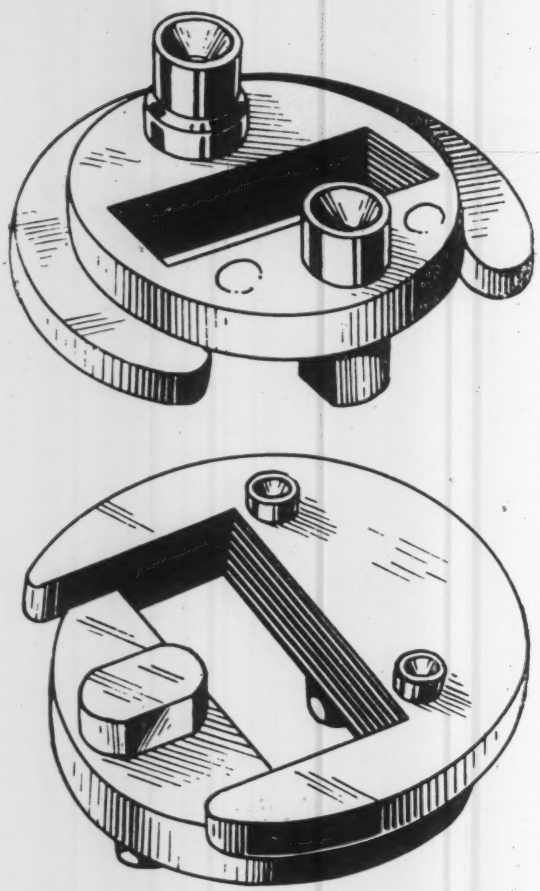


Fig. 3—Small die casting has four integral rivets recessed at the ends, an oblong cored hole and a boss with rounded ends, all of which make close fits with mating parts

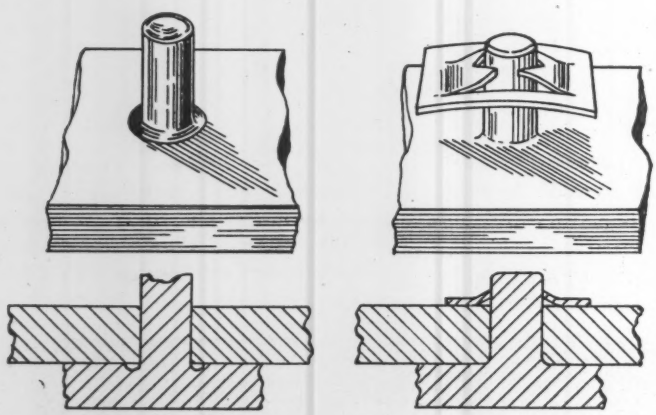


Fig. 4—Detail of integral stud on casting for quick-fastening and locking devices

with the hub of the smaller part and a core forms a keyway in the mating hole. Lest this permit slight angular displacement, however, an integral dowel pin is cast near the outer diameter of the smaller part and, when the parts are assembled, the dowel enters a mating cored hole in the other part and locks the castings in perfect angular relation. The extra integral key and pin add little to the cost of the castings but these elements obviate making and fitting a separate key, cutting two keyways, providing a separate dowel and drilling holes for it.

By casting shrouds integrally with the gears, their teeth are strengthened and flash, which comes at the edges of the shrouds, is easily sheared off with a simple trim die. All gear teeth are clean and free from burrs, minimizing the cost of flash removal. Cut gears could be used for an assembly of this kind but if cams too were to be cut on the faces and an eccentric provided, the machining costs would be exceedingly high. By die casting the cams and eccentric integrally, the only extra cost is for the added metal used and for the additional work required in building the production dies.

Integral Rivets Simplify Assembly

When a unit is die cast in two sections that are to be fastened together permanently, marked savings in assembly cost can be attained by providing for integral rivets on one half and mating cored holes on the other portion. Such a unit is shown in *Fig.* 2. In this instance, the two castings are simply placed in mating position and set into the fixture shown. In the fixture is a heading punch for each of the 13 integral studs. A single blow from the ram of a press heads all the studs and the assembly is completed. This is far faster than applying and heading separate rivets and the cost of purchasing, stocking and handling such rivets is saved. Die cost is not increased over that for coring rivet holes in both halves and the ductile zinc alloy used is easily headed yet forms a secure fastening.

Another economy realized in this unit is the provision of square cored holes in the mounting flange. Screws having a square shank portion to fit the holes are provided so that screws do not have to be held against turning when the assembly is mounted.

Similar economies are attained in the small casting shown in *Fig.* 3. This part has four integral rivets with recessed ends so designed as to be spun over or spread with punches when attached to mating parts. The oblong hole is precisely cored and the boss with rounded ends is shaped by the casting die. Both fit mating parts and could not be produced as rapidly, with dimensions so closely held, by other methods.

Many parts such as shown in *Fig.* 4, are provided with integral studs to be fastened by speed nuts. The latter hold firmly and are not easily removed from a stud of

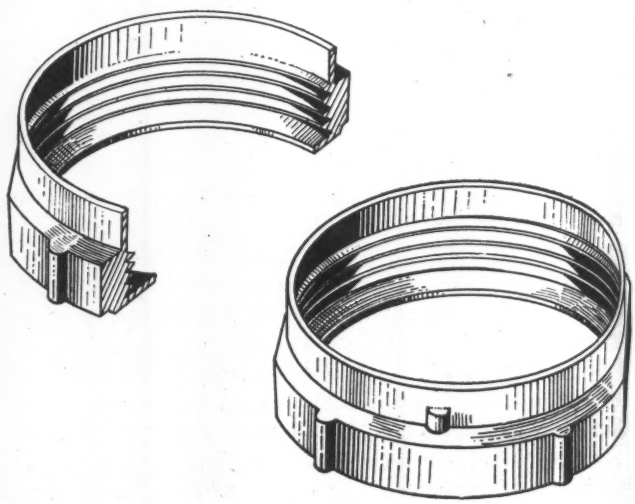


Fig. 5—Socket has cast-in internal thread. Lip at the upper edge is spun over after assembly in its mating hole

circular section but, if removal is desired, a stud of D-shaped section can be employed. Integral studs are often made with shoulders to space the mating part a given distance away. Tubular studs are also provided on some die castings and can be made to telescope with mating parts that form locating pilots.

Cast Threads Extend to Shoulder

Shown in *Fig.* 5 is a socket produced as a small zinc-alloy die casting. It has an internal cast thread that extends to a shoulder, being formed by a core that is automatically unscrewed as the die opens. At the top of the casting is a thin lip next to an external shoulder on which are cast two small semicircular ribs. This casting fits into a hole in a radio chassis of sheet aluminum. When seated in the hole against the external shoulder the lip is spun over and the part cannot turn because the ribs fit mating notches in the hole pierced in the aluminum sheet forming the radio chassis.

This single die casting took the place of two screw-machine products, the socket itself and an external nut for locking it to the chassis. Besides costing less the die castings yielded the following advantages: The socket is one-piece construction affording a secure fastening that cannot loosen as a separate lock-nut sometimes did; is short because thread extends to shoulder; cannot turn in hole; requires no tapping operation; and needs no external thread or nut.

Male threads are cast on many parts and, in general, are so precisely shaped that no subsequent chasing is needed. Such threads are shown in *Fig.* 6, all being formed by split sections of the die. Flash is left at the parting and is cut off in the trimming operation unless chasing, which is seldom needed, is done. Occasionally, male threads are formed by a part of the die that is unscrewed and this leaves no flash on the thread but makes the die more expensive and casting rates are likely to be slower.

Die castings are readily provided with small portions

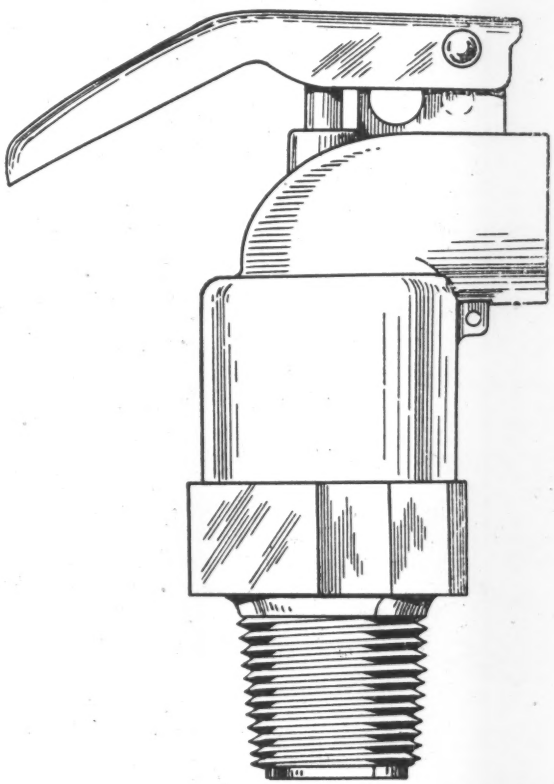


Fig. 6—Male threads formed by split sections of the die. In general no machining other than flash removal is required

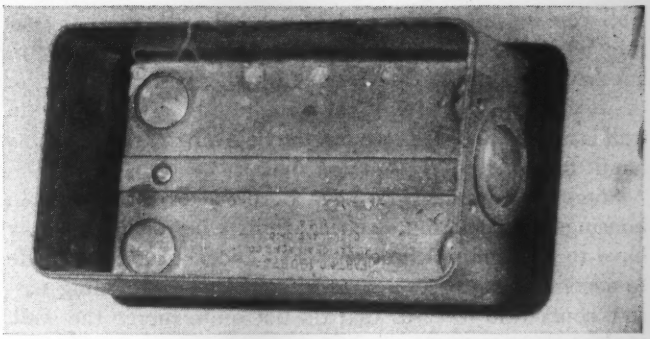
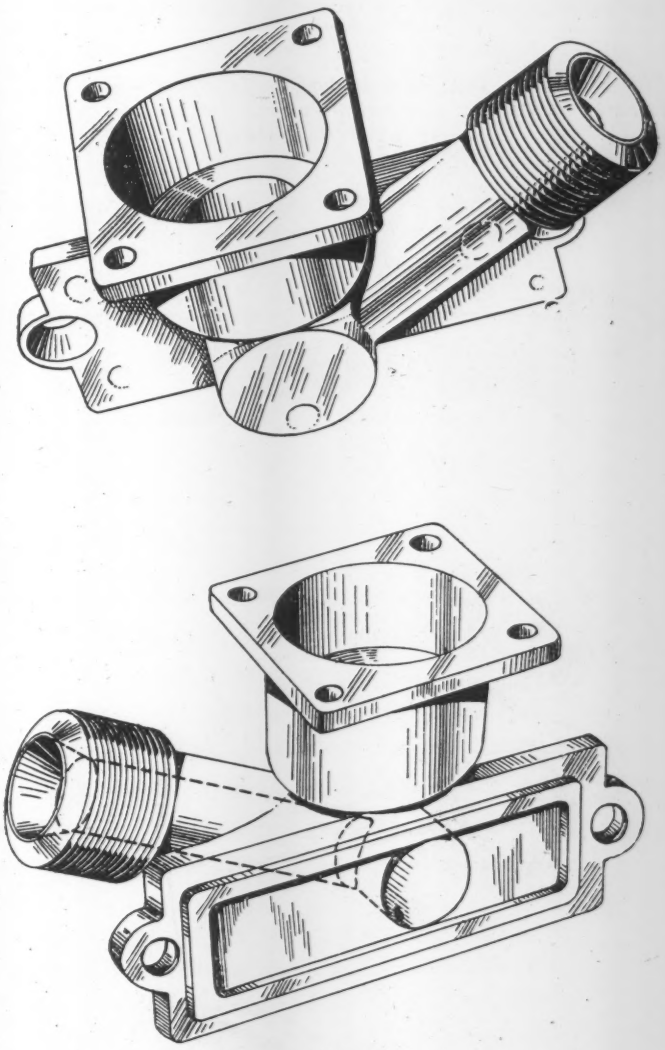


Fig. 7—Above—Knock-out walls in bosses may be left in or removed according to application requirements

Fig. 8—Below—Three precisely cored passages, a cast thread and six cored holes, three of which are countersunk, are provided in this part



that can be knocked out without machining. Thus, a thin wall can be left at the end of a blind hole such as that in a boss, *Fig.* 7, which hole forms a bearing. If, say in another adaptation of the same casting, the shaft resting in the bearing has to be brought through the casting, the thin wall is merely knocked out and the hole edge scraped with a hand tool.

Somewhat similar knockout portions are often left in housings for enclosing electrical units where conduits may have to be brought through. The knockout can be made to accommodate several sizes of conduit by providing narrow concentric recesses that do not quite pierce the wall. If the knockout is not needed, the wall remains continuous and smooth on one side and provides a perfect seal.

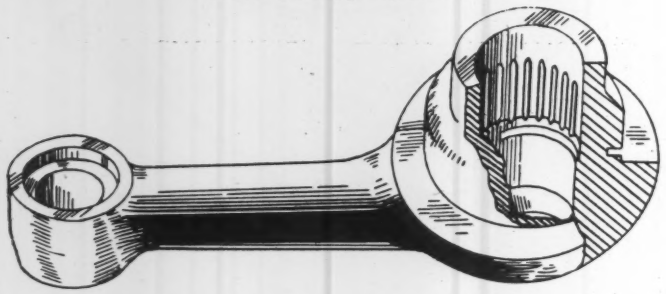
Cored Holes May Have Many Shapes

Holes and recesses that cannot be cored in other types of castings, either at all or with equal precision as to size and center distances, are easily cored in die castings. They can have almost any shape or contour, can be countersunk or recessed, *Fig.* 8, and (at least with zinc and other low melting alloys) can be cored to tapping size. Reaming is sometimes necessary but no drill jig is required, as a rule, and a reaming jig is rarely needed.

When holes have serrations, splines or a keyway or are square, the shape can be formed by the core. Often this saves separate broaching operations the fits being satisfactory for many purposes. If sizing is needed, only a small amount of metal need be removed. Parts having tapered holes with serrations for fastening to stems, *Fig.* 9, are easily die cast.

At the same time, the handle in *Fig.* 9 may be cast with ornamentation and with surfaces so smooth that the casting can be plated after a minimum of surface preparation, such as light buffing.

Fig. 9—Below—Hub hole in handle is cored with serrations to fit a stem. Surface is smooth and may be plated after buffing operation



Multiple Dies Provide Economy

Several parts can be produced in a single cycle of a casting machine. These may be all duplicates or different castings. The group of castings in *Fig.* 10 is from four unit dies held in a single chase. The two handles have internally serrated hubs formed by cores. And the two knobs also have cored-out hubs and coarse serration on their outer diameter. The circular part is cored out to form a hollow cap. The fourth unit is a group of eight small castings. For some types of parts, the economy of multiple dies is so great that, where minimum cost is essential, it becomes almost mandatory to cast several other parts in the same combination die or in unit dies used simultaneously.

Although the foregoing are by no means the only economies possible in the design of die-cast parts, they are indicative of the savings that may be effected by taking advantage of design expedients offered by this process.

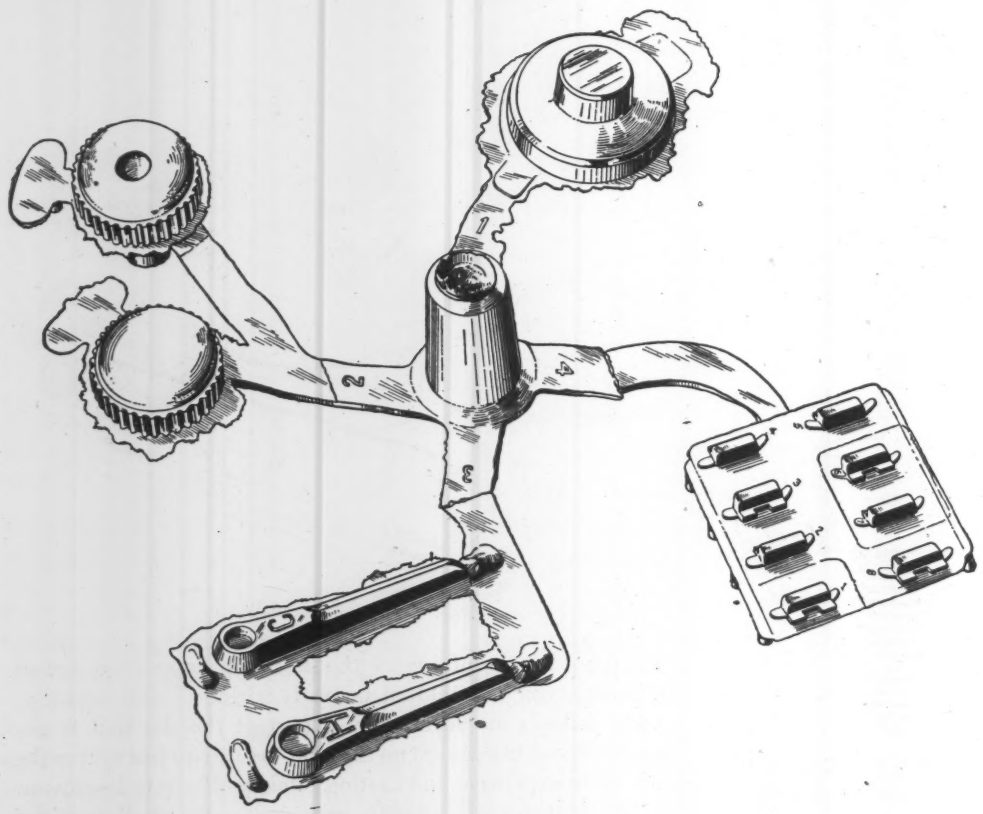


Fig. 10—Left—Group of miscellaneous zinc-alloy castings produced in four unit dies, providing economy in production for small lots

MACHINE Editorial DESIGN

High Productivity Is Best Answer

INCREASES in wages cannot come, with any degree of stability, without increases in production. This is one of the primary factors in the current labor unrest that is overlooked, intentionally or otherwise, by most labor leaders.

Insistent and ever-recurring demands for higher pay and at the same time reduced hours of work cannot fail to bring about a calamitous situation unless a near-miracle happens. It has been said that a gross national output representing a value of 170-billion dollars, which constitutes a 30-billion drop from the wartime volume but a substantial increase over peacetime peaks, will be necessary to keep employment on a sufficiently high level and to maintain the country's economic system.

Such a level of production, and the employment it represents, obviously cannot be reached if the prices of goods soar—as they necessarily must—to take care of rises in wages. The only solution seems to be a higher level of production per manhour, enabling more goods to be produced and sold at reasonably moderate prices.

Many arguments have been put forward against a constantly increasing rise in production of this nature, as brought about primarily by the use of higher speed machinery and to some extent by increase in efficiency of the worker. The fact remains, however, that increase in productivity over the years, averaging about 2-1/2 per cent, has resulted in constant improvement in wage levels, higher standards of living, and—a much more vital consideration—the ability to provide sufficient equipment to bring the war to a successful conclusion.

It has been proved also that the "per capita" use of high-speed machines has a corresponding effect on levels of wages. As compared with Great Britain and Germany, for instance, during the time that the amount of machinery per capita in this country was roughly double that employed by the other two, the wage level here was three and four times as high respectively as in the other countries.

Unless all the factors bearing upon production per manhour and its effect on prices and wages are taken into consideration by labor leaders, the country is apt to head into another depression rather than to go forward to stabilization and prosperity. The designer of machines can be expected to provide the tools; it is up to labor to use them effectively.

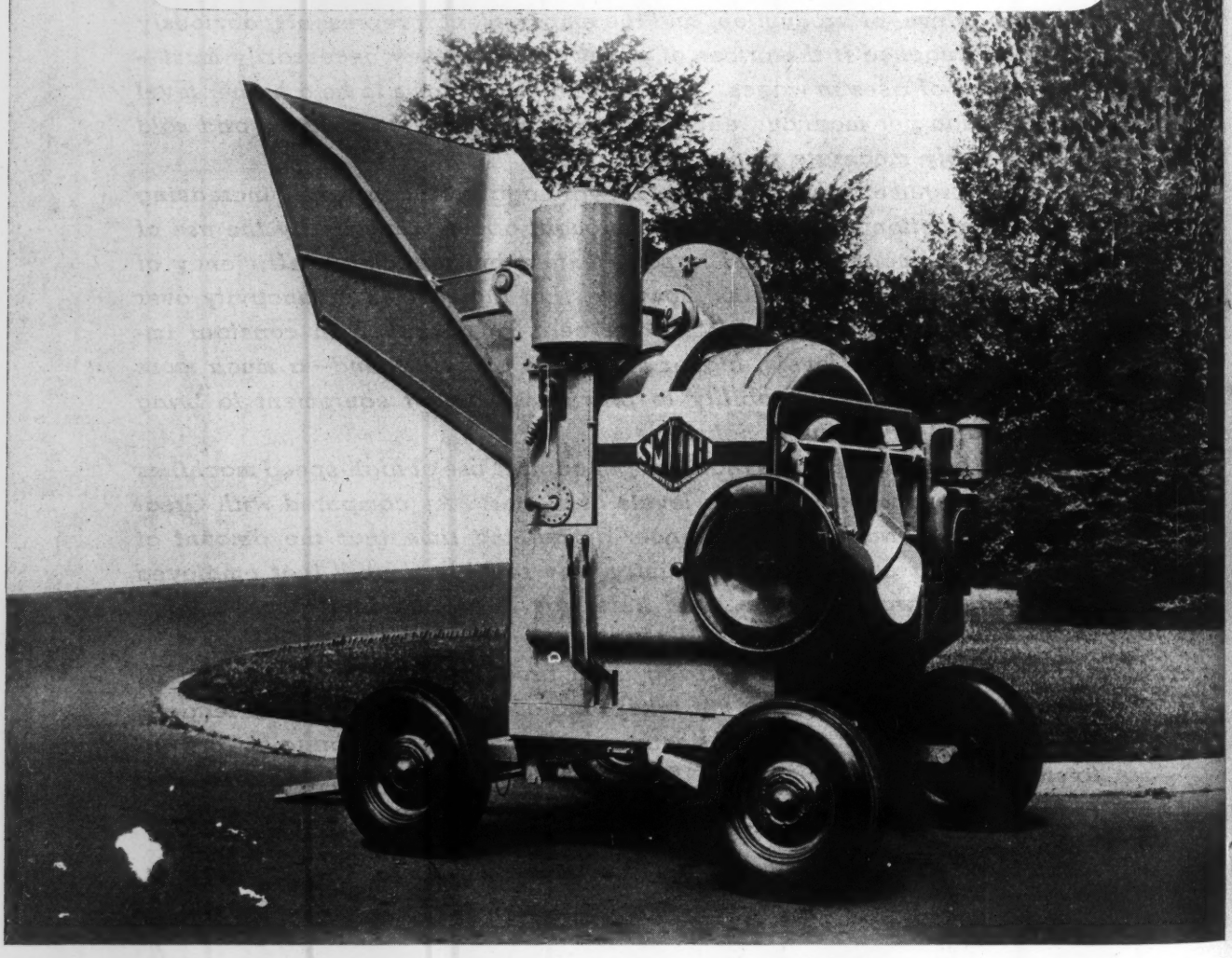
L. E. Jermy

Outstanding Designs

Concrete Mixer

With frame of electrically welded high-carbon steel plate and pressed steel drum heads, this concrete mixer designed by Karl Brocken for T. L. Smith Co. is equipped with individually sprung wheels (knee-action). This type of suspension, combined with automotive-type steering, makes possible better weight distribution and permits high-speed towing without damage to the mixer. Gear reductions for drum drive and skip hoist are contained in one unit. Power loading-skip which puts batch material into the drum is open-end type rather than closed-end type generally employed. Water tank is mounted at operator's side of machine, permitting him to change the tank setting without necessity of climbing on top of the mixer.

Improved appearance was obtained by replacing the usual spoke-type discharge handwheel with a spun disk wheel and by properly shaping the required guard plates. All styling is functional. For example, at the operator's side the styling plate serves as a gear guard. At the engine side the plates protect the hoist mechanism from the elements and at the charging and discharge sides they serve as drip shields for the drum opening. Compared to a previous model, this machine has been reduced 20 per cent in weight without sacrificing strength. Further, it offers better portability, greater productive capacity and finer appearance.



Meat Chopper

Conventional placing of motor, gears and cutting group in a horizontal line is replaced by a right-angle arrangement in this meat chopper manufactured by Toledo Scale Co. Cutting group is installed at a gravity-feed angle, which shortens the distance traveled by the meat and eliminates back pressure due to air being trapped by the meat in the cylinder. Cylinder is held in place by a cam-type lock which automatically positions the head when inserted. Permanently sealed splash-feed lubrication is employed. Finish of the chopper is gray and white baked-on plastic.

Electric Marker

Iron circuit of this electric marker manufactured by Ideal Commutator Dresser Co. is made in two identical halves. The lower half is held stationary and the upper half is attached to the nonmagnetic stainless steel drive rod and allowed to move up and down with pulsations in the field. Collet collar within the adjusting nut is the only bearing for moving parts. It is steel upon brass and requires no lubrication.

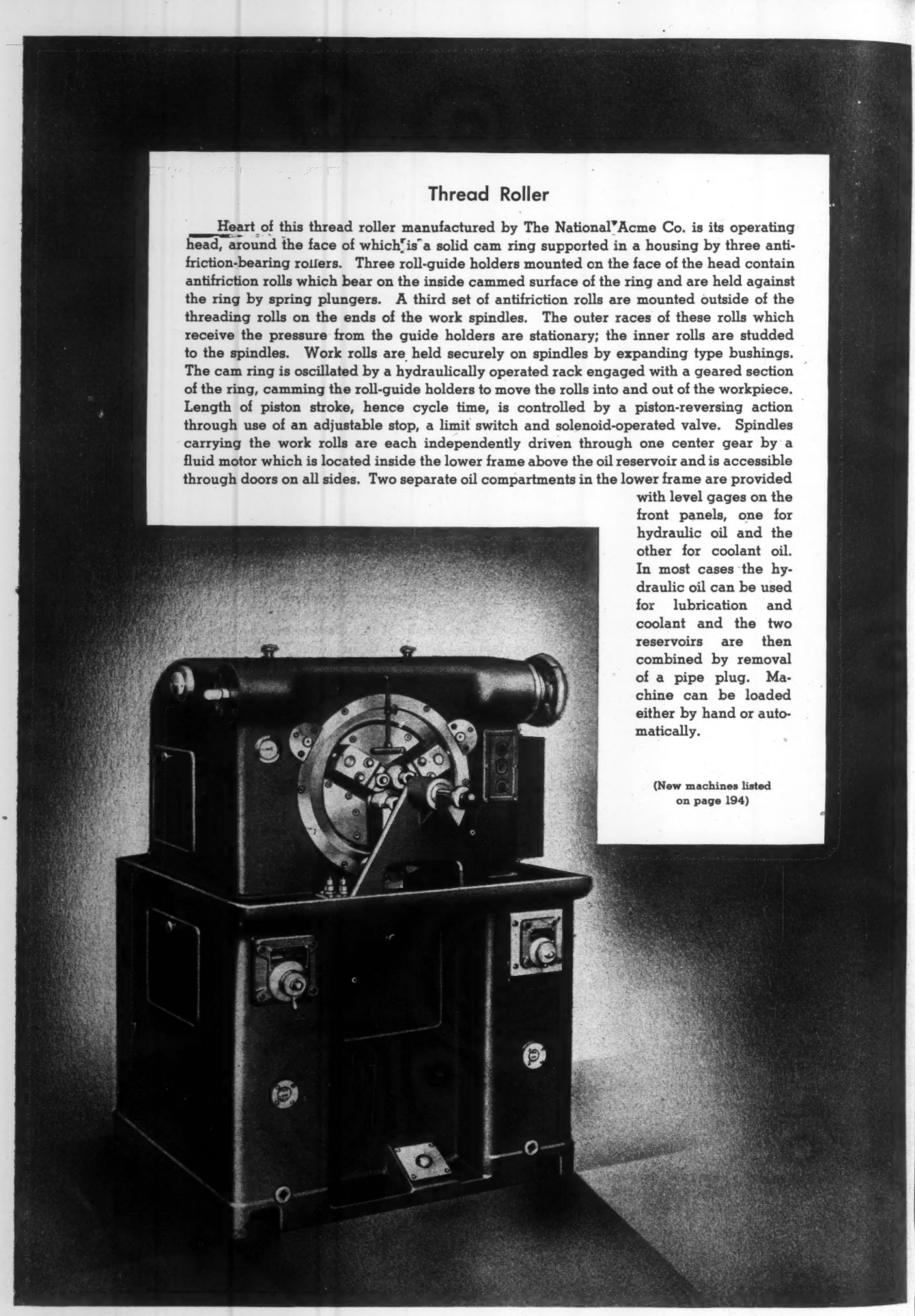
Vaporizer

Main body and handle of this electric vaporizer designed by Brooks Stevens for The Spartan Co. are of molded plastic that is resistant to heat, water and chemicals. Top is satin-brushed aluminum stamping. In operation, water from the supply chamber feeds up through a special sponge, a porous-carbon filter and a glass wool packing where it is vaporized by an electric heating element. As the dry steam is emitted from the nozzle, it picks up vapors from a molded-in medicant chamber located directly under the nozzle opening.

Thread Roller

Heart of this thread roller manufactured by The National Acme Co. is its operating head, around the face of which is a solid cam ring supported in a housing by three antifriction-bearing rollers. Three roll-guide holders mounted on the face of the head contain antifriction rolls which bear on the inside cammed surface of the ring and are held against the ring by spring plungers. A third set of antifriction rolls are mounted outside of the threading rolls on the ends of the work spindles. The outer races of these rolls which receive the pressure from the guide holders are stationary; the inner rolls are studded to the spindles. Work rolls are held securely on spindles by expanding type bushings. The cam ring is oscillated by a hydraulically operated rack engaged with a geared section of the ring, camming the roll-guide holders to move the rolls into and out of the workpiece. Length of piston stroke, hence cycle time, is controlled by a piston-reversing action through use of an adjustable stop, a limit switch and solenoid-operated valve. Spindles carrying the work rolls are each independently driven through one center gear by a fluid motor which is located inside the lower frame above the oil reservoir and is accessible through doors on all sides. Two separate oil compartments in the lower frame are provided with level gages on the front panels, one for hydraulic oil and the other for coolant oil. In most cases the hydraulic oil can be used for lubrication and coolant and the two reservoirs are then combined by removal of a pipe plug. Machine can be loaded either by hand or automatically.

(New machines listed on page 194)



Charts Aid in Specifying Gear-Pin Sizes

By William T. Taylor

Part 1

TODAY'S PRACTICE for standard spur and helical gear measurement is limited almost entirely to pin sizes which have dimensions already computed, hence the pin method of measurement is narrowed down to the use of commercial gear-pins based on one or two pin constants only. Should the required pin size differ from any of these it is rendered useless until laborious calculations are made to determine the over-pin or between-pin dimension.

A pin size other than that for which there are established pin dimensions may be required where the commercial pin is too large and projects too far beyond the lands of the teeth or is too small and drops too far below. There are other reasons, a too common one being the nonavailability of the commercial pin.

This data sheet portrays graphically a multiplicity of pin constants and their corresponding over and between-pin factors for even and odd-tooth gears, enabling the solution of measurement problems where available pin sizes differ from commercial gear-pin sizes. Two charts (*A* and *B*) are presented in this issue, and the remaining three (*C*, *D* and *E*) will appear next month.

Although it is known that pin sizes may be such as to contact tooth faces at points away from the pitch circle, today's practice still aims at finding the pin size, d, for each diametral pitch, P; that is, by first determining the pin size from $d = x/P$, where x, the pin constant, is fixed while d varies with P, or the size of tooth. The pin method of measurement is thus restricted to a minimum number of pin sizes and pin constants and their corresponding over or between-pin dimensions.

Introducing a multiplicity of pin constants permits use of standard wire-gage sizes, millimeter sizes converted to inches, fractional-inch sizes, and all existing commercial gear-pin sizes; hence it is necessary to digress from today's practice of finding the unknown d to suit an assumed or an available pin constant, x. Instead, a check is first made to see what pin size is available and then $x = dP$ is determined. If the pin size is not too large or too small, locate x at the base of the appropriate chart, then move vertically upward from x to N, the intersection giving the k value.

Equations for finding the over and between-pin dimensions M, are as follows:

For external spur gears, Charts *A*, *B*, *C* or *D*

$$M = \frac{k + (N+2)}{P} \quad \ldots\ldots (1a)$$

For internal spur gears, Chart *E*

$$M = \frac{k + (N-2)}{P} \quad \ldots\ldots (1b)$$

where k = Tooth factor found from the chart
N = Number of teeth in gear
P = Diametral pitch.

For external helical gears with even teeth, Charts *B* or *D*

$$M' = \frac{k' + (N'+2)}{P'} \quad \ldots\ldots (2a)$$

For internal helical gears with even teeth, Chart *E*

$$M' = \frac{k' + (N'-2)}{P'} \quad \ldots\ldots (2b)$$

where k' = k-value for tooth number $N'' = N/\cos^3\phi''$
N' = $N/\cos\phi''$ = Tooth number for equivalent spur gear
P' = $P/\cos\phi''$ = Normal diametral pitch
ϕ'' = Helix angle

For external helical gears with odd teeth

$$M'' = (M' - d)\cos\frac{90}{N} + d \quad \ldots\ldots (3a)$$

where M' is found from Equation 2*a*.

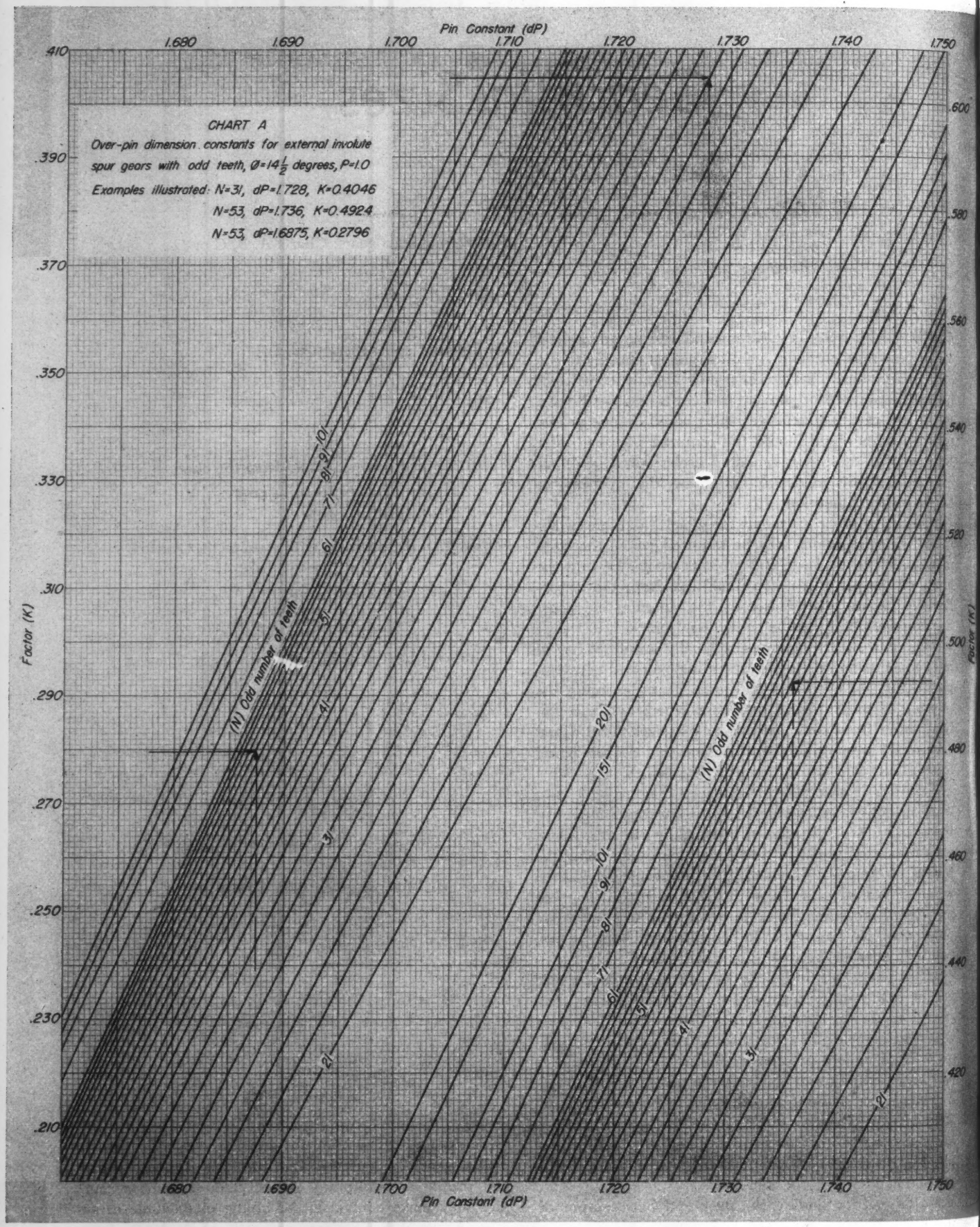
For internal helical gears with odd teeth

$$M'' = (M' - d)\cos\frac{90}{N} - d \quad \ldots\ldots (3b)$$

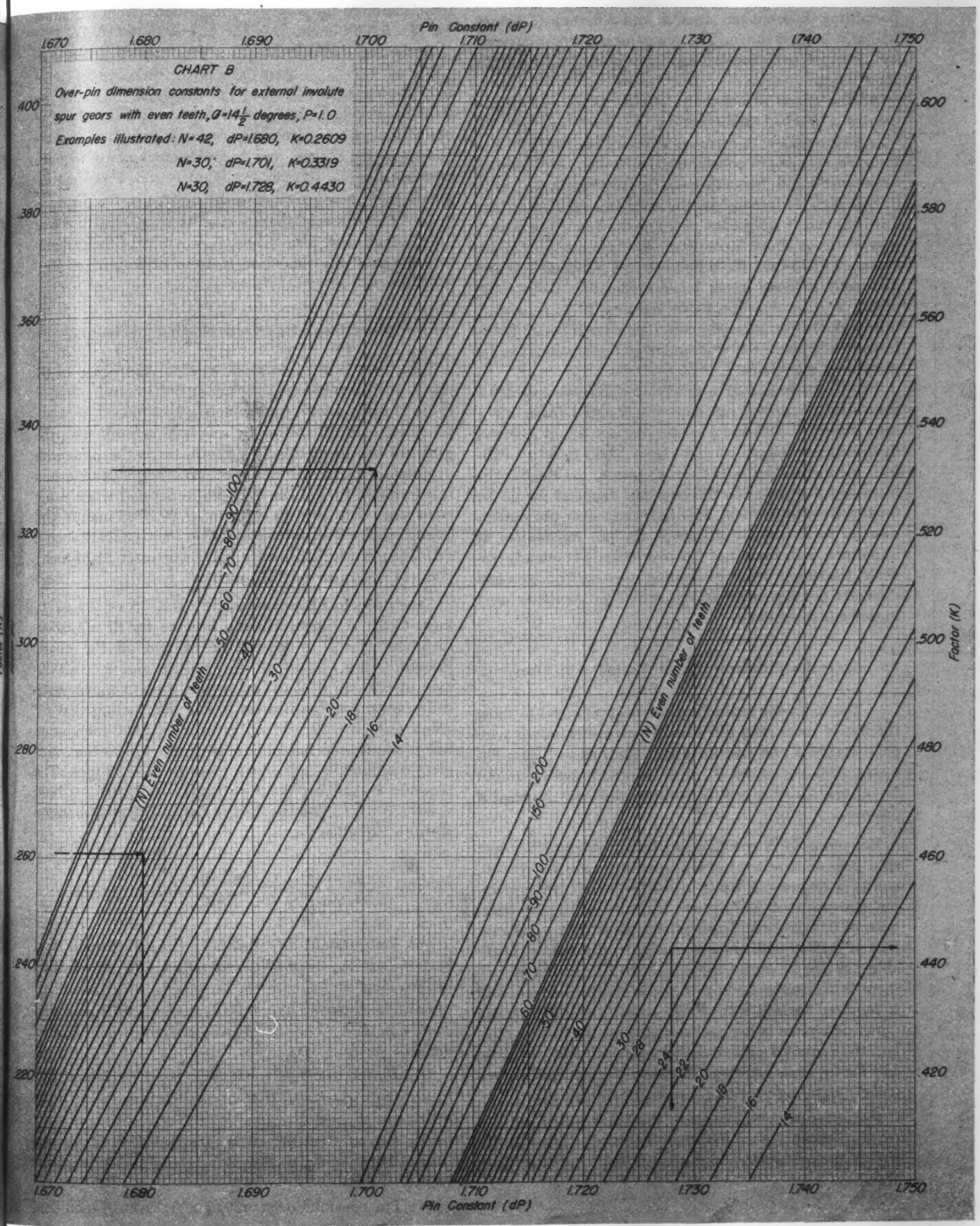
where M' is found from Equation 2*b* and M'' is the over or between-pin dimension for odd-teeth helical gears.

It is generally accepted that the involute tooth angle and profile are uniformly correct and that measuring pins may make contact either at the pitch circle or at other points along the involute profile of the teeth, thus

Engineering Data Sheet



Engineering Data Sheet



permitting different pin sizes, d, and different dP values within a limited range. The pin-constant range covered by Charts *A* to *D* inclusive is 0.08-inch (1.67 to 1.75) for $P=1.0$.

All the charts reveal that a slight change in factor k creates a marked influence on the tooth number, N, which increases with increase in diametral pitch, P. For instance, where pin constant is 1.678-inch, k difference between 60 and 70-teeth gears is 0.005-inch, i.e., only 0.0005-inch difference in the over-pin dimension for $P=10.0$ and N difference of 10 teeth; hence the reason why N values above 50 or 40 are given in intervals of 10. For $x=1.7275$-inch the difference in k between 100 and 150-teeth *external* gears is approximately 0.013-inch, where $k'=k$-value for tooth number $N''=N/cos^3\phi''$ this amount. For internal gears (see chart *E*) this k difference is so slight that odd and even teeth values can be plotted on one chart.

The charts reveal an appreciable difference in k for a small change in the pin constant, $x=dP$. Thus, for a spur gear of $N=30$ and $\phi=14\frac{1}{2}$ degrees, Chart *B* shows that changing the pin constant from 1.680-inch to 1.690-inch increases k by 0.0415-inch; hence, for $P=6.0$ the increased dimension on the over-pin diameter would be $0.0415/6=0.0069$-inch. This change in over-pin dimension for such a slight change in the pin constant, x, is important and must not be overlooked. It clearly reveals the importance of finding the correct over-pin diameter corresponding to the actual pin diameter used in this measurement.

Examples Illustrate Use of Various Pin Sizes

The following examples have been planned to show the use of measuring pin sizes which are *standard* wire gage numbers and fractional inch sizes as well as millimeter sizes converted to inch values. It goes without saying that existing commercial pin sizes may be used if desired.

EXAMPLE 1: A specification for an external involute spur gear of standard tooth proportions calls for $N=30$, $\phi=14\frac{1}{2}$ degrees, $P=6.0$, $d=0.2800$-inch, with over-pin dimension of 5.3734-inch and allowable plus tolerance of 0.0009-inch. The engineer finds that measuring pins of 0.2800-inch are not available, the nearest available pin size being 9/32-inch (0.2812-inch), for which there is no corresponding over-pin dimension value. It is required to find from these charts (a) the over-pin dimension when using each set of these measuring pins, i.e., the *required* pins and the *only available* pins; and (b) for the same spur gear, the over-pin dimension when using measuring pins of 7.4 m/m (0.2913-inch).

SOLUTION: (a) Pin constant for the required pin size is $dP=0.2800 \times 6=1.680$-inch, and from Chart *B*, $k=0.2450$-inch, therefore the overpin dimension is, from Equation 1*a*,

$$M=\frac{0.2450+(30+2)}{6}=\frac{32.2450}{6}=5.3741 \text{ inches}$$

Pin constant for the only available pin size is $dP=0.2812 \times 6=1.6872$-inch, and from Chart *B*, $k=0.2742$-inch, therefore the over-pin dimension is, from Equation 1*a*, $M=5.3790$-inch.

Assuming that the M value for $1.680/P$ is used in place of $1.6872/P$ there is a plus difference in M of 0.0058-inch which exceeds the allowable tolerance by 0.0049-inch. Hence the need for caution in the first place always to use corresponding x and M values as shown in the charts, and in the second place to have numerous ready-reference x values and their corresponding M values available.

(b) Pin constant in this case is $dP=0.2913 \times 6=1.7478$-inch, and from Chart *B*, $k=0.5234$-inch, therefore the over-pin dimension is, from Equation 1*a*, $M=5.4205$-inch.

When Gear Has Odd Number of Teeth

EXAMPLE 2: An odd-tooth external spur gear of 31 teeth, 14½-degree pressure angle, 6-diametral pitch, is to be measured with pins which, when placed between the teeth, are off center by one-half a tooth, i.e., the pins are not diametrically opposite as is the case with even-tooth gears. Six different sizes are available and it is required to find the over-pin dimension when using each size; they are: (a) 7.1 m/m (0.2795-inch); (b) Wire No. K (0.2810-inch); (c) 9/32-inch (0.2812-inch); (d) 7.2m/m (0.2835-inch); (e) 7.3 m/m (0.2874-inch) and (f) 7.4 m/m (0.2913-inch).

SOLUTION: (a) Pin constant $dP=0.2795 \times 6=1.6770$-inch. Chart *A* shows that the k value for $dP=1.6770$-inch and $N=31$ is located below and off the chart; therefore, first locate dP for $N=31$ and $k=0.2000$-inch at bottom of chart. From this x point move vertically upward to the nearest N line intersecting that dP value (say $N=39$) which gives $k=0.2200$-inch, then follow the $N=39$ line obliquely downward to the intersection of 1.6770-inch which gives $k=0.2130$-inch. The required k value is $0.2000-(0.2200-0.2130)=0.2000-0.0070=0.1930$-inch; hence the over-pin dimension is, from Equation 1*a*,

$$M=\frac{0.1930+(31+2)}{6}=\frac{33.1930}{6}=5.5322 \text{ inches}$$

(b) Pin constant $dP=0.2810 \times 6=1.6860$-inch, and from Chart *A*, $k=0.2306$-inch, therefore $M=5.5384$ inches.

(c) Pin constant $dP=0.2812 \times 6=1.6872$-inch and from Chart *A*, $k=0.2352$-inch, therefore $M=5.5392$ inches.

(d) Pin constant $dP=0.2835 \times 6=1.7010$-inch and from Chart *A*, $k=0.2928$-inch, therefore $M=5.5488$ inches.

(e) Pin constant $dP=0.2874 \times 6=1.7244$-inch and from Chart *A*, $k=0.3902$-inch, therefore $M=5.5650$ inches.

(f) Pin constant $dP=0.2913 \times 6=1.7478$-inch and from Chart *A*, $k=0.4853$-inch, therefore $M=5.5809$ inches.

MACHINE DESIGN'S

MATERIALS WORK SHEET

FILING NUMBER
7.03

Cast Steels

Chromium and Molybdenum Alloy Types

ASTM SPEC. NOS.: A148-44 ,A157-44, A217-44T

As indicated in previous Work Sheets on cast steels, specifications of the American Society for Testing Materials (ASTM) covering cast steels generally fix only the *minimum* mechanical properties. Properties higher than those listed can be obtained by varying the chemical compositions and by subjecting cast parts to various heat treatments in collaboration with a competent foundryman.

PROPERTIES PRESCRIBED IN ASTM SPECIFICATIONS

ASTM Specification No.	Class	Heat Treatment*	Tensile Strength (min, psi)	Yield Strength (min, psi)	Elong. in 2 in. (min, %)	Red. of Area (min, %)
Alloy-Steel Castings for Structural Purposes						
A148-44	B1	A, N or NT	85,000	55,000	22	44
A148-44	B2	A, N or NT	90,000	60,000	22	45
A148-44	B3	A, N or NT	100,000	65,000	18	30
A148-44	C1	N or QT	90,000	65,000	20	45
A148-44	C2	N or QT	120,000	100,000	14	35
A148-44	C3	N or QT	150,000	125,000	10	25
Alloy-Steel Castings for Valves, Flanges and Fittings for Service at Temperatures from 750 to 1100 Degrees Fahr.						
A157-44 (C-Mo)	C1	A or NT	70,000	45,000	22	35
A157-44 (Cr-Mo)	C3A	A or NT	90,000	60,000	18	30
A157-44 (Cr-Mo)	C3B	A or NT	90,000	60,000	18	30
A157-44 (4 to 6% Cr, Mo)†	C5A	A or NT	90,000	60,000	18	30
A157-44 (4 to 6% Cr, Mo, Si)†	C5B	A or NT	90,000	60,000	18	30
Alloy-Steel Castings Suitable for Fusion Welding for Service at Temperatures from 750 to 1100 Degrees Fahr.						
A217-44T (C-Mo)	WC1	A or NT	70,000	45,000	22	35
A217-44T (C-Mo)	WC1A	A	70,000	40,000	20	35
A217-44T (C-Mo)	WC2	A or NT	65,000	35,000	24	35

*A=Full Annealed; N=Normalized; NT=Normalized and Tempered; QT=Quenched and Tempered.
† With or without tungsten.

CHARACTERISTICS

Chromium Cast Steels: Chromium is one of the most widely used alloying elements in the manufacture of steel castings. It improves a steel's heat resistance, its high-temperature mechanical properties, and its resistance to chemical action. Also, chromium steels have higher static strength than plain carbon steels, accompanied by little corresponding loss in ductility.

Low-Chromium Cast Steel: Chromium content in these ordinarily runs from 0.50 to 1.00 per cent. Carbon content normally ranges from 0.15 to 0.40. However, for wear resistant applications the range is from 0.40 to 1.00 per cent, being dependent on the type of casting and its intended use. As normalized and tempered, these steels develop strength values that are similar to the medium-manganese

MACHINE DESIGN is pleased to acknowledge the collaboration of the Steel Founders' Society of America in this presentation. Much of the data included is based on the Society's *Steel Castings Handbook*.

steels. Normally expected values are listed in the tables.

2 to 3 per cent Chromium Cast Steels: These have a combination of toughness and hardness that makes them suitable for wear-resistant parts. Typical properties are listed in the table "2 to 3 per cent Chromium Cast Steels".

4 to 7 per cent Chromium Cast Steels: Addition of chromium in amounts from 4 to 7 per cent noticeably increases the corrosion resistance of a steel. It also increases resistance to scaling at moderate temperatures. Because the ductility of straight chromium steels is low, often small additions of molybdenum, vanadium, titanium or nickel are made. Molybdenum also improves resistance to creep. Typical mechanical and creep properties are given in the tables.

Chromium-Molybdenum Cast Steels: Addition of molybdenum to chromium cast steel increases tensile strength, yield point, resistance to impact and creep, and in particular, improvement is noted in ductility. These steels have excellent properties in the normalized and tempered state and also in the liquid-quenched and tempered condition. Good air-hardening qualities permit their use for large or intricate castings that require deep hardening but are not suitable for liquid quenching. Molybdenum reduces the tendency toward temper brittleness exhibited by certain chromium-containing alloy steels.

These steels are generally divided into two classes: One, used largely for structural parts, the other for corrosion and creep-resistant service. The former contains chromium from 0.50 to 1.50 per cent; the latter contains chromium in one case of 1.25 to 2.25 per cent and in the other of 4 to 6 per cent. Molybdenum is about 0.50 per cent in all cases.

0.5 to 1.5 per cent Chromium-Molybdenum Cast Steels: General analysis range of these is: 0.25 to 0.50 C, 0.50 to 1.50 Cr, and 0.20 to 0.50 Mo. For highly abrasive service, carbon runs as high as 1.00 per cent along with high alloy contents because these steels can be hardened to about 500 brinell by air cooling. For heavy parts subject to impact, a higher molybdenum content is considered advantageous. Where castings of this type steel are of simple design and thin-sectioned, excellent yield point values can be obtained in the liquid-quenched and tempered condition.

2 per cent Chromium, 0.5 Molybdenum Cast Steels: Usual composition falls within the following ranges (percentages): 0.20 to 0.30 C, 1.75 to 2.25 Cr, 0.45 to 0.60 Mo,

MEDIUM-CARBON CHROMIUM CAST STEEL

(normally expected values)

(0.39 C, 0.84 Mn, 0.48 Si, 0.79 Cr)

All test coupons preliminary-annealed at 1650 F

Quench Temp. (F)	Quench Medium	Tempering Temperature (F)	Tensile Strength (psi)	Yield Point (psi)	Elong. in 2 in. (%)	Red. of Area (%)	Brinell Hard. No.
1550	Air	None	120,800	74,400	8.5	12.6	241
1550	Air	700	122,600	77,850	13.5	20.0	228
1550	Air	1200	110,850	67,150	17.0	25.0	217
1550	Oil	700	193,600	156,350	3.5	3.5	418
1550	Oil	900	163,650	143,250	8.5	14.1	340
1550	Oil	1200	120,450	90,200	16.0	35.7	241

2 TO 3 PER CENT CHROMIUM CAST STEELS

(normally expected values)

Composition (%) C	Mn	Si	Cr	Heat Treatment* (F)	Tensile Strength (psi)	Yield Point (psi)	Elong. in 2 in. (%)	Red. of Area (%)
0.36	0.41	0.23	3.00	1650 AC, 1250 T	118,000	94,000	23	51.0
0.36	0.78	...	2.97	1650WQ, 1150 T	151,000	127,000	14	29.0
0.36	...	...	3.00	1650 OQ, 1100 T	147,000	110,000	10	29.9
0.36	0.78	...	2.97	1600 OQ, 1150 T	142,000	122,000	15	34.0
0.36	0.78	...	2.97	1500 OQ, 1150 T	138,000	120,000	16	37.0

*AC = Air cooled; WQ = Water quenched; OQ = Oil quenched; T = Tempered.

LOW-CHROMIUM CAST STEELS

(normally expected values)

Composition (%) C	Mn	Si	Cr	Heat Treatment* (F)	Tensile Strength (psi)	Yield Point (psi)	Elong. in 2 in. (%)	Red. of Area (%)	Brinell Hard. No.	Izod Impact (ft-lb)
0.26	0.90	0.68	0.65	1650 AC, 1550 AC	84,000	51,000	33.0	63.0	...	...
0.33	0.74	0.43	0.79	1650 AC, 1250 T	92,000	51,000	20.0	32.0	202	32
0.34	0.71	0.37	0.77	1650 AC, 1250 T	90,000	51,300	20.0	36.5	223	...
0.35	0.69	0.38	0.77	1550 AC, 1250 T	95,500	54,600	19.0	32.0	207	30
0.36	0.80	0.40	0.90	1650 AC, 1250 T	97,400	60,000	17.0	30.0	223	28
0.37	0.73	0.47	0.80	1650 AC, 1250 T	96,000	53,540	18.0	31.0	215	28
0.38	0.81	0.45	0.80	1650 AC, 1250 T	95,600	55,000	17.9	29.0	218	...
0.39	0.76	0.36	0.88	1650 AC, 1250 T	99,500	58,400	16.0	29.0	220	26
0.42	0.70	0.39	0.93	1650 AC, 1250 T	99,000	57,750	16.0	27.0	222	...
0.43	0.76	0.35	0.78	1650 AC, 1250 T	99,150	58,400	15.0	24.0	217	20
0.45	0.75	0.50	0.70	1650 AC, 1250 T	97,500	57,000	17.0	25.0	215	...
0.59	0.83	0.35	0.82	1650 AC, 1100 T	132,000	73,000	12.0	13.0	255	...
0.70	0.64	0.39	0.79	1650 AC, 1100 T	128,000	89,000	3.0	3.0	269	3

*Ac=Air cooled; T=Tempered.

0.70 to 0.90 Mn, 0.30 to 0.50 Si. They are generally used in the normalized and tempered condition.

4 to 6 per cent Chromium, 0.5 Molybdenum Cast Steels: Air-hardening steels with ability to resist creep and corrosion at high temperatures. Composition usually falls within following ranges (percentages): 0.15 to 0.30 C, 4 to 6 Cr, 0.40 to 0.60 Mo, 0.60 to 0.80 Mn, 0.40 to 0.65 Si. Generally, for best properties, carbon content is kept at about 0.20 per cent. Low-temperature Charpy impact strength at -25 F with specimens double normalized from 1700 and 1550 F, and tempered at 1300 F, ranges from 22 to 27 foot-pounds.

CHROMIUM-MOLYBDENUM CAST STEELS
ELEVATED-TEMPERATURE PROPERTIES

(normally expected values)

No.	Composition (%) C	Mn	Si	Cr	Mo	Heat Treatment (F) Normalized	Tempered
1	0.31	0.57	0.37	4.86	0.53	1650	1300
2	0.32	0.45	0.25	5.14	0.42	1650	1300
3	0.19	0.57	0.25	6.39	0.52	1800	1275
4	0.21	0.80	0.52	8.36	0.47	1800	1270
5	0.15	0.46	0.17	4.85	0.51	Annealed 1600	....
6	0.27	0.58	0.60	5.14	0.61	1800, 1700	1250

MECHANICAL PROPERTIES

No.	70 F	300 F	550 F	900 F	1200 F
			Tensile Strength (psi)		
1	118,000	111,000	103,200	.....	44,900
2	117,000	108,800	107,200	.....	49,100
3	116,100	101,700	104,000	.....	44,800
4	120,000	100,000	104,400	.....	43,200
5	72,675	.....	.....	57,000	.....
6	116,500	.....	101,000	84,000	43,000
			Yield Point (psi)		
1	90,300	89,000	77,500	.....	18,000
2	91,500	88,500	90,500	.....	23,000
3	95,800	84,000	88,000	.....	23,000
4	99,300	80,000	85,500	.....	.....
5	31,500	.....	.....	28,500	.....
6*	87,700	.....	77,000	67,500	25,000
			Proportional Limit (psi)		
1	71,000	76,600	67,600	.....	.....
2	78,000	78,000	75,000	.....	15,000
3	.....	60,700	71,500	.....	14,000
4	.....	68,200	73,000	.....	.....
			Elong. in 2 in. (%)		
1	17.0	14.0	13.0	....	37.0
2	18.5	18.0	13.0	....	35.0
3	22.5	20.0	17.0	....	35.0
4	21.0	21.5	16.0	....	34.0
5	35.0	....	....	25.0	....
6	22.0	....	17.0	19.0	43.5
			Red. of Area (%)		
1	44.0	42.7	40.6	....	81.6
2	49.2	47.8	46.9	....	83.7
3	59.8	66.2	59.7	....	89.2
4	49.2	57.0	47.8	....	87.8
5	68.5	....	....	61.7	....
6	56.0	....	50.0	....	95.5

CREEP
(stress per 1% elongation in 10,000 hrs)

No.	800 F	900 F	1000 F
1	.....	18,000	10,000
5	25,000	15,000	.....
6	.....	25,000	8,600

* Yield stress 0.2 per cent set.

Chromium-Vanadium Cast Steels: Particularly where the carbon content is high, these steels have excellent wear resistant properties. Vanadium increases the steel's shock resistance. Normally expected properties of three representative compositions are listed in the table "Chromium-Vanadium Cast Steels". These steels often are used interchangeably with 0.5 to 1.5 Cr-Mo steels.

Chromium-Silicon Cast Steels: These generally are formulated within the following ranges (percentages): 0.15 to 0.25 C, 1.00 to 1.75 Si, and 1.00 to 2.50 Cr. They have good resistance to scaling up to 1450 F without embrittlement and offer good corrosion resistance, although not to the extent of stainless steels. Tests on a steel having 0.20 C, 0.78 Mn, 2.37 Cr, and 1.57 Si reveal the following properties:

	Normalized 1650 F	Normalized 1650 F Tempered 1200 F
Tensile Strength (psi)	108,000	85,700
Yield Point (psi)	56,650	44,900
Elongation in 2 inches (%)	13	26
Reduction of Area (%)	22.3	44.9

Chromium-Silicon-Molybdenum Cast Steels: In the lower carbon ranges, these steels show particularly desirable properties for use at elevated temperatures. Usually, castings are of simple design and thin-sectioned, permitting liquid quenching. These steels are similar to the chromium-molybdenum steels.

Chromium-Tungsten Cast Steels: These, containing 0.20 to 0.35 per cent carbon, 4 to 6 per cent chromium and 0.75 to 1.00 per cent tungsten, have good corrosion resistance and favorable high-temperature properties. These steels can be made to conform to ASTM Spec. No. A157-44, class C5A, which covers steels particularly suitable for valves, flanges and fittings for service at temperatures from 750 to 1100 F.

Molybdenum Cast Steels: Molybdenum apparently has little effect on the mechanical properties of "as cast" steels. Where it is used in heat-treated steels, however, in quantities of less than one per cent, it increases tensile strength and hardness while retaining satisfactory toughness. It intensifies the hardenability of both plain carbon and alloy compositions. Small amounts of molybdenum impart practical immunity to temper brittleness and most of these steels have, in addition, good impact resistance. Molybdenum increases the strength of steel at high temperatures, and improves yield and tensile strength and creep resistance at moderately elevated temperatures.

Carbon-Molybdenum Cast Steels: These often replace plain carbon cast steels in applications requiring high strength at elevated temperatures. Also, owing to their air-hardening properties, carbon-molybdenum steel castings develop excellent properties under a simple normalizing treatment. They are particularly suitable to structural applications where tensile requirements range from about 75,000 to 85,000 psi.

APPLICATIONS

Chromium Cast Steels: The low-chromium types are used where moderately high strength and wear resistance are required. Typical applications are: Frames and fittings on rolling mill equipment to reduce weight, in excavating and conveying equipment to reduce wear, in heavy rolls and dies for resistance to wear and heat checking, etc. Excellent steels for structural purposes.

2 to 3 per cent Chromium Cast Steels: Extremely well suited to parts in rock-crushing machines and dipper and dredge teeth.

4 to 7 per cent Chromium Cast Steels: Used for parts subject to corrosion and excessive scaling at moderate and

intermediate temperatures.

Chromium-Molybdenum Cast Steels: The .5 to 1.5 per cent chromium-molybdenum types in the various carbon ranges are used for brackets, crankshafts, gears, locomotive parts, steel mill rolls, derrick hooks, and heavily stressed machine parts. Use of this material for dies, muller tires, crusher hammers, jaws and plates, roll shells, dipper teeth and other parts subject to wear and abrasion is well established. Oil refineries are also beginning to use these steels in some creep-resistant applications.

2 per cent Chromium, 0.5 Molybdenum and 4 to 6 per cent Chromium, 0.5 Molybdenum Cast Steels: Largest field of application is in the construction of oil refinery equipment where the 4 to 6 per cent chromium type in particular is used for such parts as oil pump impellers, flow-line headers, oil pump casings, yokes, valve trim and condenser fittings.

Chromium-Vanadium Cast Steels: High-carbon grade is used for crushing and grinding machinery parts which must withstand heavy abrasive wear. A lower carbon type (0.40 to 0.45 per cent) is especially valuable for high hardness valves requiring abrasion resistance in combination with some degree of toughness.

Chromium-Silicon Cast Steels: An important application is in furnace parts for use at moderate temperatures.

Chromium-Silicon-Molybdenum Cast Steels: These are well adapted to units subject to rapidly alternating stresses such as hooks, chisels, bumpers, vibrators, etc.

Chromium-Tungsten Cast Steels: Good corrosion resistance and elevated temperature properties make these suitable for castings in oil refinery equipment. They are suitable also for hot-working dies, rolls, and pressure fittings.

Molybdenum Cast Steels: Used in rolls, hydroelectric equipment, locomotive and general machine parts subject to shock. Also suitable for valves, flanges, pump and turbine casings and comparable applications where high strength at elevated temperatures is a primary consideration. Owing to its air-hardening properties, molybdenum steel gives good results in castings which, because of their large size or intricate shape, cannot be quenched in liquid yet must have considerable hardness and tensile strength. These steels are excellent for structural purposes.

4 TO 7 PER CENT CHROMIUM CAST STEELS

(normally expected values)

Composition (%)							Heat Treatment* (F)	Tensile Strength (psi)	Yield Point (psi)	Elong. in 2 in. (%)	Red. of Area (%)
C	Mn	Si	Cr	W	Mo	Ni					
0.23	0.68	0.39	6.11	....	....	....	1650 AC, 1250 T	122,500	97,500	15	38
0.26	0.64	0.43	5.75	....	....	....	1650 AC, 1250 T	118,000	95,100	16	40
0.25	0.53	0.42	5.87	0.80	....	....	1750 AC, 1250 T	125,000	100,000	18	45
0.22	0.71	0.50	4.02	....	0.46	....	1650 AC	121,000	91,000	19	51
0.22	0.55	0.42	4.26	....	....	0.48	1800 AC, 1400 FC	100,350	75,000	19	44

*AC=Air cooled; FC=Furnace cooled; T=Tempered.

2% CHROMIUM, 0.5% MOLYBDENUM CAST STEELS

(normally expected values)

Normalized 1650 F, Tempered 1275 F

Composition (%)					Tensile Strength (psi)	Yield Point (psi)	Elong. in 2 in. (%)	Red. of Area (%)	Brinell Hard. No.
C	Mn	Si	Cr	Mo					
0.30	0.75	0.35	1.90	0.55	111,950	82,700	21.5	53.0	212
0.30	0.70	0.37	2.06	0.53	111,800	83,400	19.5	53.9	217
0.29	0.76	0.36	2.25	0.59	110,650	83,500	21.5	57.6	217
0.27	0.76	0.41	2.04	0.56	101,850	85,800	23.0	59.1	207
0.25	0.70	0.33	1.84	0.52	103,350	81,950	20.5	58.1	207
0.20	0.79	0.32	1.76	0.54	101,600	77,150	19.0	55.5	207

CHROMIUM-MOLYBDENUM CAST STEELS—NORMALIZED AND TEMPERED

(normally expected values)

Composition (%)			Heat Treatment* (F)	Tensile Strength (psi)	Yield Point (psi)	Elong. in 2 in. (%)	Red. of Area (%)	Brinell Hard. No.	Izod Impact (ft-lb.)
C	Cr	Mo							
0.25	0.75	0.29	1700 AC, 1250 T	86,300	53,850	23.4	39.8	....	....
0.28	0.76	0.20	1600 AC, 1250 T	88,000	56,500	22.0	38.0	180	....
0.31	0.68	0.25	1650 AC, 1000 T	100,500	70,000	20.0	35.0	202	22.0
0.31	0.68	0.25	1650 AC, 1200 T	89,500	59,800	22.5	44.0	190	30.2
0.31	0.68	0.25	1650 AC, 1300 T	90,970	64,350	27.0	51.0	179	31.7
0.33	0.83	0.32	1650 AC, 1200 T	92,000	61,500	24.0	43.0	....	....
0.36	0.77	0.40	1700 AC, 1200 T	96,000	63,500	22.0	42.0	....	....
0.39	0.69	0.43	1650 AC, 1250 T	103,000	70,000	19.0	40.0	....	....
0.42	0.82	0.23	1650 AC, 1250 T	109,350	75,250	19.0	33.1	235	....
0.47	1.10	0.17	1700 AC, 1550 AC, 1250 T	120,500	79,000	19.0	35.6	241	....
0.25	1.50	0.38	1650 AC, 1200 T	100,000	80,000	26.0	40.0	200	....
0.90	1.36	0.30	1525 AC, 1100 T	156,000	95,000	9.0	9.0	....	....
0.99	1.05	0.25	1525 AC, 1100 T	158,000	89,000	7.0	9.0	....	....

* AC=Air cooled; T=Tempered.

CHROMIUM-MOLYBDENUM CAST STEELS—OIL QUENCHED AND TEMPERED

(normally expected values)

Composition (%) C	Cr	Mo	Heat Treatment* (F)	Tensile Strength (psi)	Yield Point (psi)	Elong. in 2 in. (%)	Red. of Area (%)
0.32	0.95	0.20	1650 OQ, 950 T	176,500	170,000	5.5	24.6
0.36	0.89	0.15	1650 OQ, 1100 T	145,400	129,300	12.0	24.1
0.36	0.76	0.35	1600 OQ, 1250 T	111,500	85,850	17.2	35.7
0.37	0.98	0.24	1650 OQ, 1250 T	126,450	106,700	12.0	29.5
0.42	0.82	0.23	1650 OQ, 1300 T	105,700	82,500	19.0	40.1
0.44	0.75	0.30	1600 OQ, 1250 T	121,500	98,250	14.8	27.6
0.47	1.10	0.17	1550 OQ, 1250 T	117,750	89,100	18.5	37.3

*OQ=Oil quenched; T=Tempered.

ELEVATED-TEMPERATURE PROPERTIES OF CHROMIUM CAST STEEL

(0.34 C, 0.56 Mn, 0.39 Si, 6.18 Cr, 0.63 Ni)
Normalized 1800 F, Tempered 1275 F

Test Temperature (F)	Tensile Strength (psi)	Yield Point (psi)	Proportional Limit (psi)	Elong. in 2 in. (%)	Red. of Area (%)
70	120,300	97,300	.....	18.5	45.1
800	97,800	78,600	53,700	15.0	47.5
1000	66,000	46,300	21,900	28.5	80.8
1200	44,900	23,000	6,000	38.0	91.4

CREEP CHARACTERISTICS

(Stress to produce 1% elongation in 10,000 hr)

At 800 F ..... 20,000 psi
At 900 F ..... 10,000 psi
At 1000 F ..... approx. 5,000 psi

FABRICATION

MACHINABILITY:

In general, the low-chromium types of cast steel have a machinability rating of about 50 to 55 per cent as compared to 100 per cent for cold-rolled SAE 1112. The chromium-molybdenum types have ratings of from 60 to 65 per cent and the chromium-vanadium types of from 50 to 55. Often a skin on a steel casting contains bits of grit and sand which tend to wear cutting tools rapidly. This difficulty is circumvented, however, by making the initial cut on a casting a deep or hogging cut. Generally, steel in the "as cast" condition is considered more difficult to machine than after it has been properly heat treated.

WELDABILITY:

Although these steels can be welded by any of the commercial processes, normal practice in the steel castings industry is to use the electric arc. All of these steels should be preheated and stress relieved because of their high alloy content. In general, it is recommended that in sections greater than ½-inch, castings be preheated to about 300 F before welding and, after welding, stress relieved at 1100 to 1250 F. Typical properties of arc-welded joints in carbon-molybdenum steel castings welded with filler material of similar composition are:

	As Welded	Stress Relieved
Yield Point (psi)	65,000	52,000
Tensile Strength (psi)	75,000	70,000
Elongation (%))	20	30

Typical properties of arc-welded joints in 5 per cent chromium-molybdenum steel castings welded with austenitic stainless steel electrodes are:

	As Welded	Stress Relieved
Yield Point (psi)	75,000	70,000
Tensile Strength (psi)	85,000	80,000
Elongation (%)	20	25

RESISTANCE TO CORROSION

While these steels cannot be compared to higher chromium stainless steels for corrosion resistance, as the following tabulation shows, appreciable improvements are effected with increasing amounts of chromium over three per cent.

	Chromium Content of Steels (%) 0.00	1.06	2.77	4.64	7.14
Test Solution	Inches Penetration in 30 Days				
Hot aerated city water	0.200	0.030	0.010	0.009	0.011
Aerated dilute HCl	0.250	0.022	0.008	0.005	0.004
Aerated NaCl solution	0.012	0.009	0.007	0.007	0.008
NaCl solution aerated with H_2S	0.023	0.010	0.005	0.004	0.003
Aerated dilute H_2SO_4	0.024	0.020	0.013	0.010	0.007

Relative oxidation resistance of steels containing various percentages of chromium is indicated in the following. Figures given were obtained from samples which were held in an open muffle furnace at 1500 F for four weeks.

Sample	Loss in Weight (%)
Steel Plate	34
Cast Iron	36
5.47% Cr, 0.11% C	20
6.00% Cr, 0.13% C, 0.90% Ti	11
6.80% Cr, 0.06% C, 0.69% Ti	2

(Concluded on next page)

HEAT TREATMENTS

The low-chromium, 2 to 3 per cent chromium, 0.5 to 1.5 per cent chromium-molybdenum, chromium-vanadium, and carbon-molybdenum cast steels are air-hardening and generally are used in the normalized state. The carbon-molybdenum steel may be used in the full annealed condition for high-temperature applications. These steels seldom receive a double-normalizing treatment because the improvements resulting do not warrant the additional heating cycle. The low-chromium, low chromium-molybdenum and chromium-vanadium steels give excellent service with maximum toughness in the water-quenched and tempered condition. Liquid-quenching temperature ranges from about 1500 to 1550 F followed by tempering at 1100 to 1250 F. The other steels covered in this Work Sheet usually are furnished in the fully annealed or normalized and tempered condition to develop best high-temperature properties.

MATERIAL SPECIFICATIONS

In addition to the ASTM specification numbers listed on the first page of this Work Sheet, these steels also are covered by Federal Spec. No. QQ-S-681-b, grades 4B1, 4B2, 4B3, 4C1, 4C2 and 4C3 (same as ASTM Spec. No. A148-44). Applicable to the low-alloy types covered in this Work Sheet are Navy Spec. Nos. 49S1, class F, and 46S33, class A. Also applicable are AAR (Association of American Railroads) Spec. Nos. M-201, class C and M-204, class HT.

4 to 6% CHROMIUM, 0.5% MOLYBDENUM CAST STEELS—NORMALIZED AND TEMPERED

(normally expected values.)

Composition (%) C	Cr	Mo	Heat Treatment* (F)	Tensile Strength (psi)	Yield Strength (psi)	Elong. in 2 in. (%)	Red. of Area (%)	Brinell Hard. No.
0.15	4.50	0.45	1700 AC, 1550 AC, 1250 T	85,000	65,000	25.0	50.0	183
0.18	5.10	0.48	1800 AC, 1575 AC, 1300 T	90,800	63,800	24.6	55.6	176
0.20	5.16	0.58	1750 AC, 1200 T	97,000	68,500	22.0	50.2	196
0.23	5.50	0.55	1700 AC, 1250 T	103,000	83,000	20.2	40.6	216
0.25	4.72	0.40	1700 AC, 1200 T	111,000	80,800	20.5	48.2	...
0.27	5.99	0.56	1700 AC, 1250 T	106,500	77,350	18.0	45.2	225
0.28	4.98	0.47	1750 AC, 1400 T	107,000	83,000	19.8	44.0	202
0.30	4.83	0.49	1800 AC, 1250 T	111,500	87,800	20.0	45.3	...
0.30	6.50	0.65	1800 AC, 1575 AC, 1200 T	119,500	98,200	15.2	30.2	250

*AC=Air cooled; T=Tempered.

CHROMIUM-TUNGSTEN CAST STEEL

(0.20 C, 0.45 Mn, 0.50 Si, 5.90 Cr, 0.97 W)

Heat Treatment* (F)	Tensile Strength (psi)	Yield Point (psi)	Elong. in 2 in. (%)	Red. of Area (%)	Brinell Hard. No.
1750 AC, 1625 WQ, 1250 T	117,400	91,700	20.5	50.9	241
1750 AC, 1250 T	108,600	83,800	20.5	46.0	229
1750 AC, 1650 AC, 1250 T	119,500	91,900	20.0	45.7	241

* AC=Air cooled; WQ=Water quenched; T=Tempered.

CHROMIUM-TUNGSTEN CAST STEELS—ELEVATED-TEMPERATURE PROPERTIES

(0.31 C, 0.50 Mn, 0.87 Si, 4.67 Cr, 0.99 W)
Normalized 1650 F, Tempered 1275 F

Temperature (F)	Tensile Strength (psi)	Yield Point (psi)	Proportional Limit (psi)	Elong. in 2 in. (%)	Red. of Area (%)
70	114,200	86,400	74,000	19.8	45.0
550	91,900	71,000	63,000	15.0	39.6
800	85,900	65,000	42,000	16.0	41.6
1000	62,500	48,500	30,000	30.0	70.0
1200	37,500	20,500	11,000	35.0	81.5

CREEP

(stress per 1% elongation in 10,000 hr)

At 900 F	12,000
At 1100 F	Approx. 3,300

CHROMIUM-VANADIUM CAST STEELS

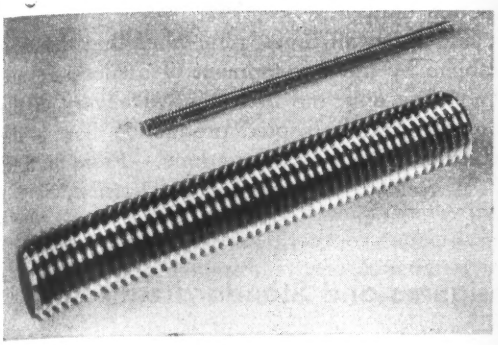
(normally expected values)

Composition (%) C	Mn	Cr	V	Heat Treatment* (F)	Tensile Strength (psi)	Yield Point (psi)	Elong. in 2 in. (%)	Red. of Area (%)
0.30	0.80	1.00	0.10	1600 OQ, 1300 T	94,300	64,850	27.5	57.1
0.33	0.72	0.93	0.19	1700 AC, 1550 AC, 1200 T	94,250	67,000	23.0	44.8
0.75	0.78	1.07	0.22	1600 AC, 1000 T	130,000	74,500	12.0	14.5

*OQ = Oil quenched; AC =Air cooled; T = Tempered.

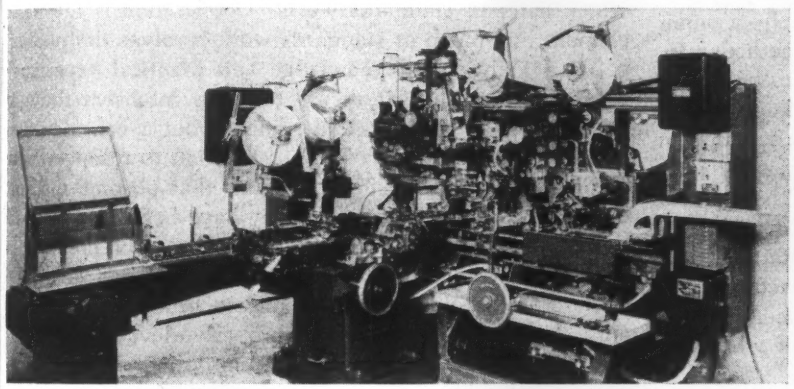
Applications

of Engineering Parts, Materials and Processes



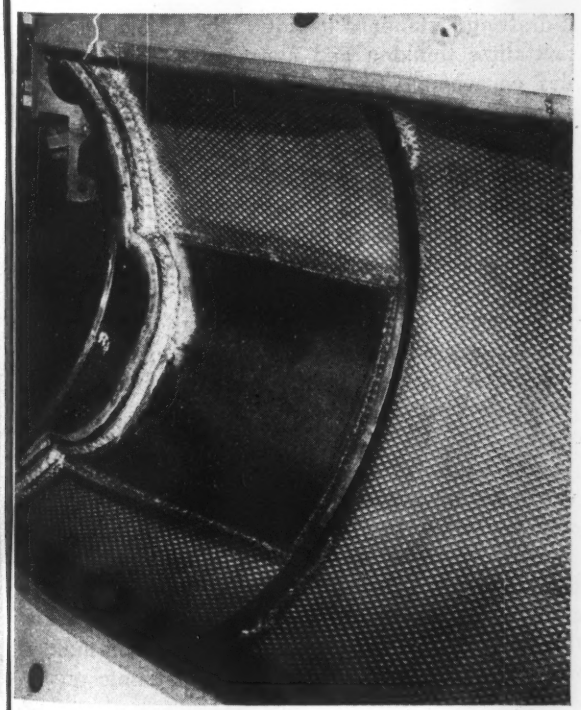
Grinds Accurate Threads

EXTREMELY accurate hardened lead screws or feed screws of varying lengths and diameters, left, can be produced easily on the Landis centerless thread grinder. With threads ground direct in the hardened blank stock, the screws are free from heat treating warpage and distortions which often present difficult production problems. Outside diameter and pitch diameter are concentric and can be held within a tolerance of 0.0005-inch. Thread form is accurate and constant throughout the length of the thread while the lead error may vary from 0.0001 to 0.0005-inch per inch.



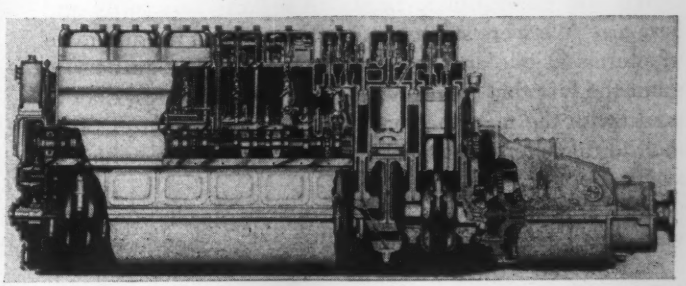
Insures Positioning

TO GUARD against the improper positioning of printed matter on chewing-gum wrappers during wrapping and packaging, two General Electric photoelectric relay and light source combinations are utilized, left. The chewing-gum wrapping machine shown wraps individual sticks and also packages the sticks in a double wrapping of both wax and printed paper. One relay controls positioning of the printed paper for sticks, the other for packages.



Reduces Weight

GIGANTIC oil pan, left, of the new Sterling Viking diesel engine, below, is fabricated from Rigidized metal, the strength of which afforded weight reduction of 1000 pounds over the original cast iron pan. Alternate concave and convex beads formed by a rolling process improve the strength as well as the torsional and flexural rigidity of the No. 6-WL Rigidized 18-gage, carbon steel sheet by an increase of approximately 80 per cent in the effective section thickness over plain 18-gage sheet. Better heat transfer is afforded by the greater surface area of the textured metal.



Design Abstracts

Foreseeing Production Limitations

CHIEF lesson we have learned as a result of the war is the saving of time in designing an instrument or even a system. To accomplish this we divide our engineers into groups, each headed by a senior engineer. Each senior engineer has several project engineers assigned to him. To each project engineer, an instrument or a device is assigned. It is his responsibility to design, develop and test the unit and to release it to production. Any troubles in production are his troubles and it is up to him to solve them.

He starts with a problem given to him, conceives the design, develops it in accordance with specifications by the customer and puts the design through development and testing. When the order is received he works closely with Tool Design, going through Production and seeing that all production difficulties are taken care of, either by a minor change in design or by changing production methods. Inspection, which reports to Engineering, watches on behalf of the engineers to see that the products are in accordance with specifications and drawings. The first installation in the field often is made by the project engineer, or at least closely supervised by him. Any difficulties in the field reported by Service are immediately transmitted to the project engineer. The product is his "baby" from start to finish as long as it exists. As soon as routine manufacturing begins to take more of the load, the project engineer starts to develop an improved model incorporating in it what was learned from production and field application.

Experimental Model May Go into Production

We tell our engineers that the success or failure of a product shows on the drafting board; that thought must be given to simplicity of design. We have trained our engineers to think in terms of dies, castings, stampings, coinings and to do so from the design of the first model. It is just as easy to design for production from the first as it is to do it any other way. If the experimental model is successful, it may go into production without change. There may not be time or the need for the product may be so urgent that there is no time to redesign it. In any case a redesign for production of an experimental model must be tested again. It is not the same product that was originally tested and its characteristics may not be the same.

We and many others began in cellars, backyards and garages. We were salesmen, draftsmen, foremen and manufacturers at one and the same time. We had to bear in mind the fact that it was necessary to make our product at home with the machines on hand. Another quarter of an inch in diameter might mean we had no lathe in which to swing the part.

While the limitations now are not so specific or so severe, this kind of thinking is still deeply imbedded in our minds. By being production-conscious, we have been able to work fast. This has meant cutting time and cutting corners between the conception of an idea and the delivery of the production unit.

We must, and do at all times, remember that the solution of a problem by the development of a successful experimental model is only the first step. Delivery of the equipment in large, uninterrupted production flow is the only indication that the job has been done.—*From an SAE paper by W. A. Reichel, Eclipse-Pioneer Division, Bendix Aviation Corp.*

Designers and Standardization

STANDARDIZATION, in the popular conception, is frequently a misnomer and the cause of a prejudice which hampers standards work. Cooperation is the basic element, inasmuch as standards work involves the pooling of the widely varied knowledge and practical experience of able specialists. It serves to focus intensive thought on a particular problem and brings about a consideration of all its aspects. It is often a revelation to discover how great are the possible improvements that become evident under scrutiny in parts which may have been given broad but uncritical use for years. This process of creating a standard, the focusing of attention on a limited field, the clash of viewpoints, and the sincere group effort to secure the best result, give to properly developed standards a quality that is seldom found in normal design. The process has a by-product of a value not often appreciated or even recognized. In a new or difficult field, 90 per cent of the effort may be expended before the actual work of drafting a standard begins. The discussions, however, crystallize thinking and assist in establishing basic principles on which sound design can proceed. Sometimes a year or more may pass before a concrete standard is evolved.

Standardization is one important answer to the increasing complexity and multiplicity of today's technical developments. Some aspects of these are so great as almost to overwhelm us, or at best to serve as a serious drag on our industrial efficiency, unless brought under control by organization and systemization of details. Designers dealing with new problems are not too keenly aware of the seriousness of the trail left behind them, which must be dealt with by manufacturing, stores, and maintenance.

The rapid tempo of recent times has made evident a trend worth noting because it is a partial answer at least to one of the chief barriers standardization has always faced, namely, the fear which many able designers have of standardization. This is a sort of claustrophobia—a feeling that once a standard has been set up it is a fixed dead thing. Any study of recent standardization indicates the contrary is true; it is a progressive dynamic process.

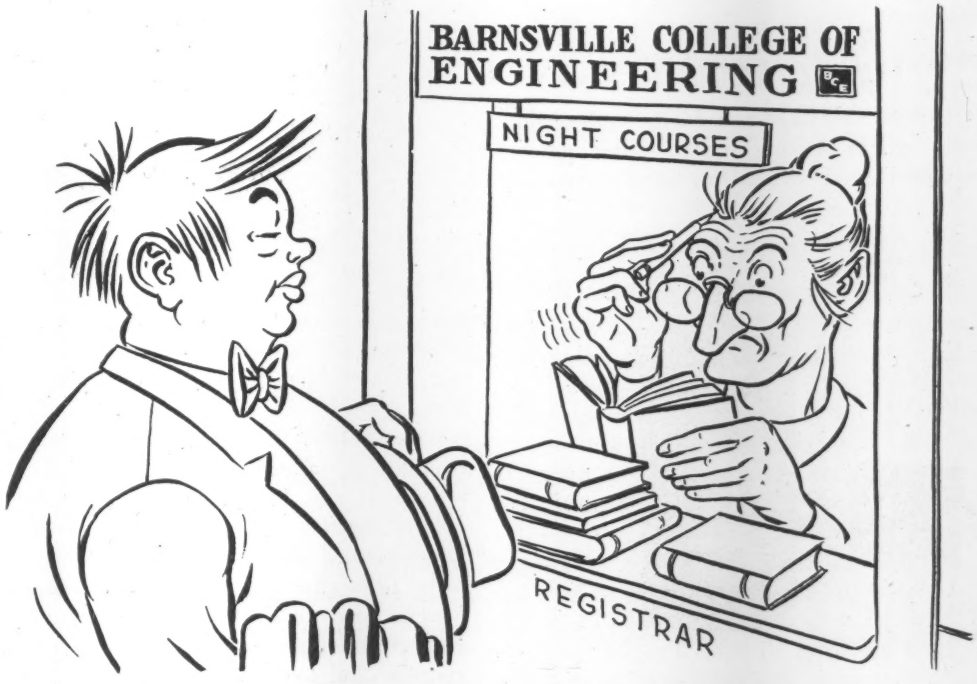
Yet the fact that a standard is a flexible and living creation that may be changed in a year to incorporate features making it a better standard does not affect its value as a standard, controlling for a period of time the design of a product as does a jig or fixture which is likewise subject to change.

One of the broad trends in standardization work that has become increasingly evident within the last year or two is the enlargement of its scope. While much remains to be done in the matter of standardizing simple or "element" parts, the standardization of more complex parts and assemblies opens another extremely important and relatively new field. Certain airplane components because of their nature have always been in effect standards, in that the same items are used on many types of airplanes. Such components are engines, propellers, wheels, tires, brakes, instruments, and many equipment items. Designers are accustomed to having these furnished and with few exceptions accommodate the airplane design to their dimensional and functional requirements. However, other parts through precedent have always been considered as under the airplane designer's control and are normally special for each airplane. They constitute a field somewhat jealously guarded by designers.

Owing to the aggressive action of the NASC electrical and hydraulic subcommittees, the lines have started to crumble in a number of places during the last year. It was found, in the case of circuit breakers, connector panels, relief valves, hand pumps, and 4-way selector valves, that technical requirements made it necessary to take cooperative action, through standardization, in order to secure proper function and quality. Naturally, a reduced cost followed the standardization. The point to be emphasized is that technical requirements compelled better design and better tooling than is generally possible in the case of a specific design for a given airplane.

With other parts or assemblies more intimately affecting the airplane, there is still the strong feeling that they must be tailored to the individual airplane, necessitating new design and new tooling in each instance. It is felt that this is a debatable assumption, that there are not a few instances where a really well-engineered design would be suitable for many airplanes. If a designer were given such a part as a standard, he would make the necessary adjustments and compromises which are inherent in the design process. The airplane would not suffer, while the part in question, as a result of the thought of many engineers during its standardization, should be lighter, superior functionally and better from the production standpoint than with individual design. With larger requirements the tooling can be more extensive and the production cost less; sometimes only one half or one quarter. Thus is created another "building block." A large slice of design time can be devoted to improving the arrangement and basic structure of the airplane.

Such an extension of the standards field carries one important implication. Work of this type normally cannot be done effectively by a "standards" engineer, though his cooperation is quite essential; it is a task for design engineers working cooperatively. Thus if we are to realize the further great gains possible by large production of many airplane components not now standard, a certain amount of time and effort must be allowed designers for standardization activities. Their active participation in such work would render it more realistic and of higher quality; it would also assist in breaking down present barriers to this fertile and profitable field.—*From a paper by B. C. Boulton, Douglas Aircraft Co. Inc., presented at the recent Aviation War Conference of The American Society of Mechanical Engineers in Los Angeles.*

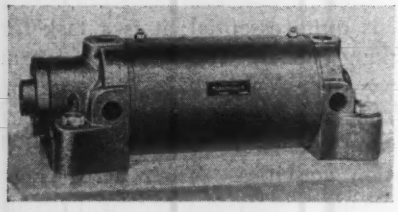


"Sorry, sir, there are no courses in 'know-how' listed"

NEW PARTS AND MATERIALS

Hydraulic Cylinders

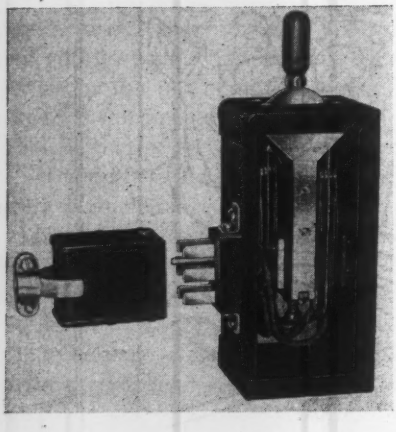
HYDRAULIC CYLINDERS for use in industrial, processing and materials-handling equipment, etc., have been introduced by Logansport Machine Co. Inc., Logansport, Ind. Centrifugal-cast barrels and other design features provide for maximum power without leakage. These Rotocast cylinders are adapted for a wide range of operations involving pushing, clamping, lifting, forcing, holding,



pulling, pressing and other power movements. Available with cushioning at one or both ends, if desired, the cylinders are offered in seven mounting types, three piston-rod models and nine standard bores. Although designed primarily for oil, they may be used for water service if the water is treated. If untreated water is to be used, cylinders of special material can be supplied. They are built for operating pressures to 1500 psi.

Extra-Heavy-Duty Lever Switch

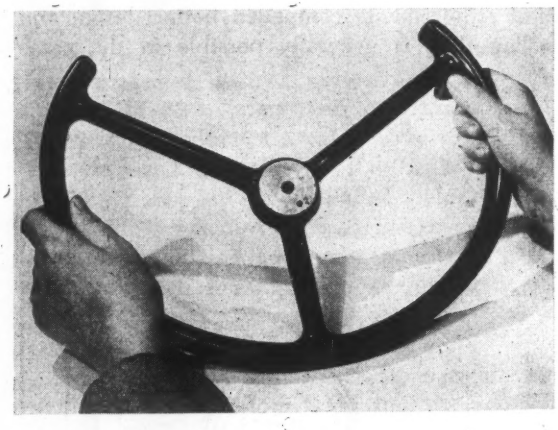
FOR CONTROLLING reel motors on looms in the nylon and rayon industry, or for starting and plugging motors, a new extra-heavy-duty lever switch has been announced



by Donald P. Mossman Inc., 612 North Michigan Ave., Chicago, Ill. The switch is removable and portable, and permits servicing without shutting down of more than a single loom. This Series 4101-KP switch is rated at 20 amperes, 110 volts alternating current (noninductive). Its size is approximately 2 3/8 x 2 3/8 x 5 1/4 inches. The switch is mounted in a metal box and wired to the terminal plug. Connector is a standard type plug or socket with locating pins for easy connection. A special housing is lint, dirt and dust-tight.

Lightweight Cellulosic Plastic

MADE FROM cellulose and propionic acid by a new process by Celanese Plastics Corp., division of Celanese Corp. of America, 180 Madison Ave., New York 16, Forticel thermoplastic material can be injection and extrusion molded into machine parts. Finished parts offer an unusual surface luster and brilliant mold finish obtained without any mechanical polishing. Molding cycle can

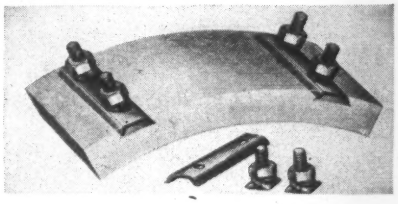


frequently be reduced with Forticel. The new plastic is odorless and has a low specific gravity of about 1.2 or less and, according to the company, where 100 molded pieces are obtained from a pound of cellulose acetate, 108 pieces can be obtained from Forticel. Having a high impact strength, it offers longer life to parts molded of this material. It can be furnished in any color, as well as in colored mottles and intricate color designs. Because of its low moisture absorption, its electrical properties are said to be little affected by changes in atmospheric conditions. Special types of Forticel will be manufactured into sheets and continuous films for use where good dimensional stability and toughness are required. These forms would lend themselves to all kinds of fabricating operations. The applications of the plastic include radio housings, steering

wheels, telephones, appliances, dials, electrical insulation, etc. The material has a high dielectric strength with a low power factor and a low dielectric constant. Its toughness permits all kinds of machining and fabricating operations, such as heat forming, drawing, milling and cementing. Parts of Forticel can also be printed without running into trouble due to tackiness.

New Type Brake Blocks

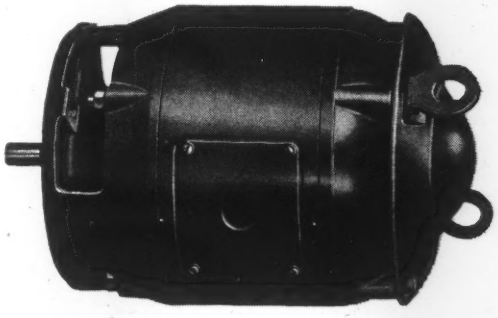
INTRODUCED BY Raybestos-Manhattan Inc., Passaic, N. J., the Key-Lok brake block consists of lateral "fishtail" metal strips or keepers in which bolts are inserted, spaced to fit in the brake bands. The keepers slide into fishtail slots cut into the block. Bolts, bands or shoes never need be removed for relining; all that is necessary is to loosen keeper nuts slightly, replace the lining, tighten bolts and make normal adjustments. Some of the advantages claimed for the brake blocks include quick change, less danger of



springing bands, elimination of foreign matter deposits in bolt holes, elimination of scoring, increasing friction surface area, increasing holding ability of block to shoe, adaptability of block to both internal and external applications and reduction of installation and maintenance costs.

Vertical Dripproof Motors

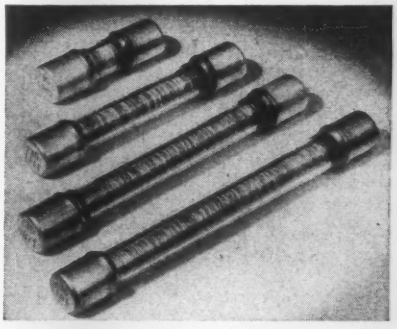
VERTICAL DRIPPROOF motors have been added to the line of protected-type a-c motors produced by the Crocker-Wheeler Div., Joshua Hendy Iron Works, Ampere, N. J. Rated at 40 C rise for continuous duty with a 15 per



cent service factor, the motors operate on 60 or 50 cycles, 3 or 2-phase circuits at all standard voltages. Available at present are NEMA "B" flange type mountings up to and including the "284" frame, and NEMA "C" face type mountings up to and including the "326" frame. Ventilating openings are shielded against entrance of dripping liquids and falling particles. Oversize ball bearings are provided to carry thrust in addition to the rotor. A centrifugal bearing seal permits use of softer grease for better lubrication and longer bearing life.

Rectifiers Utilize Aluminum

SELENIUM RECTIFIERS which have been added to the line of industrial electrical equipment produced by Radio Receptor Co. Inc., 251 West Nineteenth St., New



York, meet requirements for a modern a-c to d-c conversion unit. Aluminum has been utilized in place of iron or similar metals, and a method of sealing the unit hermetically has been developed, assuring maximum performance under climatic conditions ranging from the Arctic to the Tropics. In addition, the use of aluminum has reduced the weight of the unit by two-thirds, and at the same time enables more efficient heat dissipation. An increased margin of protection beyond normal plate rating has also been provided. A wide range of units are included—from 25 mils to capacities of hundreds of amperes—thus offering the unit required by each industrial application, for all combinations of voltage and current outputs and for various types of circuits. The rectifiers are used in relay circuits, welding, electroplating, magnetic devices, telephony and railway signaling. They have advantages of being able to operate at high ambient temperatures, of not being too susceptible to moisture and of displaying good aging characteristics.

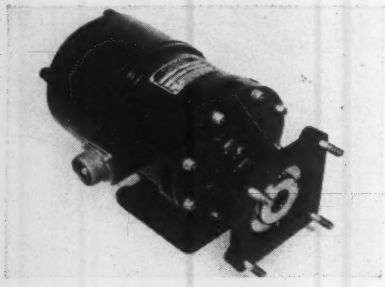
High Nickel-Bearing Steel Tubing

RECENTLY ANNOUNCED by The Babcock & Wilcox Tube Co., Beaver Falls, Pa., tubular forms of 9 per cent nickel steel are now available. Developed primarily to answer the pressure tubing needs in handling liquefied gases or other low temperature fluids, the new high nickel-bearing steel tubing exhibits good physical properties even at temperatures as low as −320 F. As a substitute for 18-8 stainless steel tubing, the material will have particular applications in oil refineries and the chemical industries. Also where a difficult corrosion problem is present, such as in oil wells where salt water and hydrogen sulphide is in the oil fluid, the tubing can be used in special pumps. The tubing is capable of giving Charpy impact values as high as 25 foot-pounds, even at −320 F. It offers resistance to attack by alkaline media and to low temperature

embrittlement, and can be pierced, rolled and drawn. Ultimate tensile strength is 80,000 psi; yield strength, 50,000 psi; and elongation in 2 inches is 20 per cent.

Lightweight Gearmotor

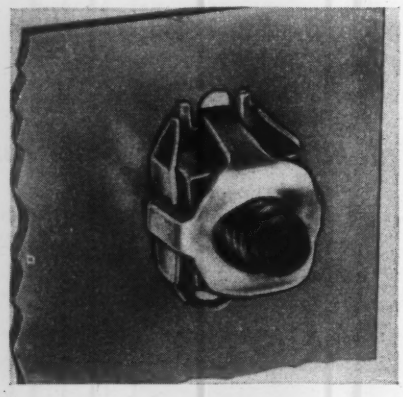
FIRST OF A group of new lightweight continuous duty gearmotors has been introduced by Jack & Heintz Inc., 17600 Broadway, Cleveland 1. Originally designed for aircraft pumps, the motors are adaptable for other similar applications and are available in various sizes. Model JH-



13100, illustrated, is designed for 28-volt direct-current systems, and is rated for continuous duty at 3 horsepower with a speed of 3800 rpm at the splined output shaft. Developed to operate at 40,000 feet altitude, this self-cooled motor weighs 19 1/2 pounds and occupies a cylindrical space of approximately 6 inches by 10 1/2 inches.

Anchor Type Lock-Nut

FOR USE ON sheet-metal installations where it is convenient or necessary to have the nut member held in place during assembly, a new anchor lock-nut has been announced by Kaynar Mfg. Co., 820 East Sixteenth St., Los



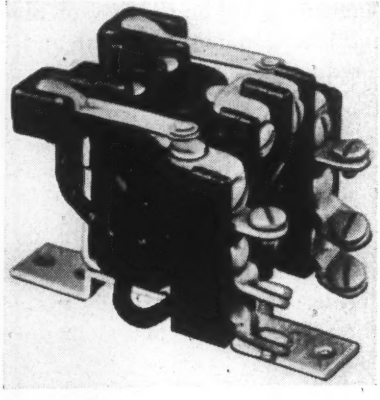
Angeles 21. The lower half of the fastener is a "carrier" for the nut and is tempered spring steel with a "built-in" lockwasher. The upper half, also spring steel, keeps a square nut contained within the assembly. Two spring ears projecting from the lower part are used to engage the sheet of metal to which the nut is to be attached. The part that receives the nut is provided with two 5/32-inch diametrically opposed holes and spaced a specified distance from the center hole. The anchor nut assembly is then snapped into place by hand, the nut floating freely with respect to the center hole to allow for alignment. While only the one size, ¼-inch, is now available, other sizes will be offered in the near future.

Cellular Glass Insulation

ACCORDING TO a recent announcement, improvements have been made by Pittsburgh Corning Corp., 632 Duquesne Way, Pittsburgh, in its new cellular glass insulation known as Foamglas. The number of cells per cubic foot has been increased from 5,000,000 to 10,000,000 thus providing additional thermal protection. Also the "K" value or conductivity has been improved. This inorganic material for cellular insulation is composed of specially-prepared glass, cellulated under intense heat, making the insulation fireproof, waterproof and verminproof. Its inorganic nature makes it permanent as it is not subject to deterioration from common elements.

A-C and D-C Magnetic Relays

SINGLE AND TWO-POLE a-c and d-c magnetic relays for industrial and electronic applications are being offered by R-B-M Mfg. Co., Div. of Essex Wire Corp., Logans-

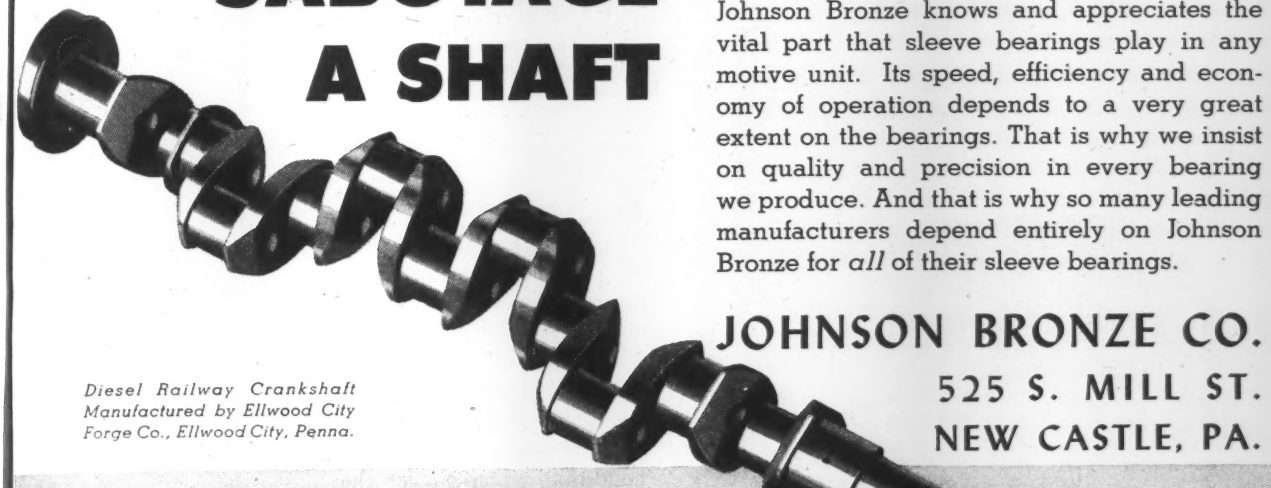


port, Ind. They are rated 10 amperes at 24 volts direct current and 110 volts alternating current, 5 amperes at 220 volts alternating current. Contact arrangement is single and double-pole; normally open, normally closed, or double-throw, with silver-to-silver contacts. Armatures are self-aligning. Relays, which may be mounted either from front or rear, have identical bases for complete interchangeability. All relays are available in open-type or with sheet steel, general-purpose enclosure.

Vents with Rupture Diaphragms

MANUFACTURED by J. A. Zurn Mfg. Co., Erie, Pa., safety vents in cast bronze, steel, semisteel or cast iron, with flange or butt-weld connections, are available in a wide range of sizes. Offering protection against fire and

HOW TO SABOTAGE A SHAFT



Diesel Railway Crankshaft Manufactured by Ellwood City Forge Co., Ellwood City, Penna.

● The crankshaft is an important, expensive part of the modern, high speed engine. It represents many hours of precise, highly skilled workmanship. Yet the crankshaft can be sabotaged in a few minutes . . . if the bearings are not *exactly* right. In fact, without the right fit, correct alloy and proper lubrication method, excessive wear develops or the bearings freeze to the shaft.

Johnson Bronze knows and appreciates the vital part that sleeve bearings play in any motive unit. Its speed, efficiency and economy of operation depends to a very great extent on the bearings. That is why we insist on quality and precision in every bearing we produce. And that is why so many leading manufacturers depend entirely on Johnson Bronze for *all* of their sleeve bearings.

JOHNSON BRONZE CO.
525 S. MILL ST.
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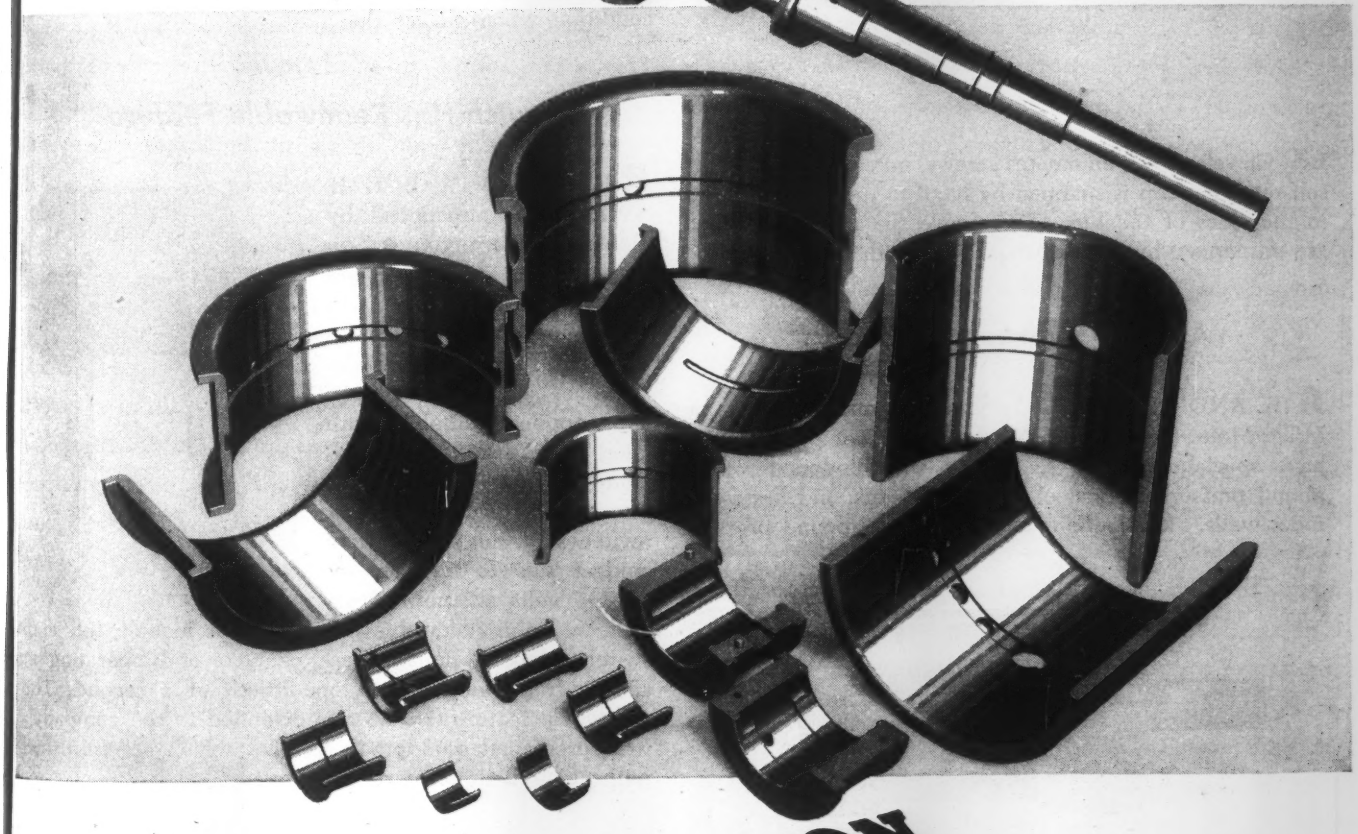


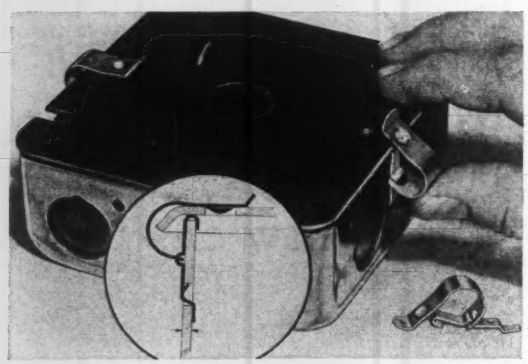
JOHNSON
SLEEVE BEARING HEADQUARTERS
BRONZE

BRANCHES IN 18 INDUSTRIAL CENTERS

explosion to tanks and processing vessels containing inflammable liquids, the safety vents are a combination vapor valve and rupture diaphragm. They contain a special disk that will break to relieve excessive pressures. In addition to this rupture diaphragm, the vents have the ordinary function of permitting a safe escape of inflammable gases from a tank, by means of a specially designed unit with perforated brass flame barrier plates.

Box Cover Fastener

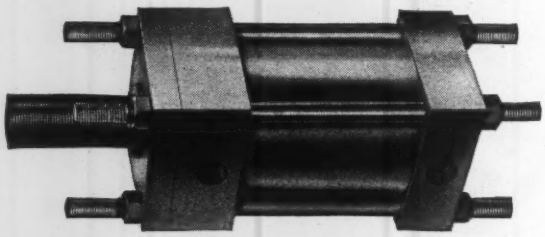
AVAILABLE FOR use on sheet-metal, die-cast, plastic or plywood boxes of varying wall thicknesses, the new spring steel fastener of Tinnerman Products Inc., 2085 Fulton



Rd., Cleveland 13, eliminates screws, nuts and rivets. This self-retaining clip is snapped by hand to prepunched holes in the sides of the box. To remove the cover, the clips are unsnapped by pushing them back with the thumb.

Air and Hydraulic Cylinders

AIR AND HYDRAULIC cylinders, manufactured by Miller Motor Co., 4027-33 North Kedzie Ave., Chicago 18, have special mounting features. Air cylinders for 200-pound pressure have steel heads and caps, and brass cylinder walls. Hydraulic cylinders for 1500-pound pressure

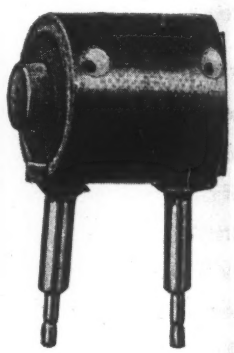


have steel heads, caps and walls. Flexibility in applications is obtained by a universal cylinder which may be mounted on extended tie rods or with any of the standard styles of brackets attached to the tie rods. Five new tie-rod mountings are available. Other features of the cylinders include: Nonbreakable fabricated steel head and cap, square in shape; piston-rod bushing locked between retainer plate and the steel shoulder of the cylinder head, regulating cup squeeze for perfect seal and long service; bushing piloted without threading into the cylinder head to preserve close fit and concentricity; all parts precision built to close tolerances and interchangeable; and identical basic dimensions and mounting dimensions for both the cushioned and the noncushioned models. In addition to these air and hydraulic cylinders, two other special cylinders have been developed. One is an air-operated hydraulic booster for use in lightweight, small, portable units, while the other is the dual-stroke welder cylinder, providing an adequate opening to insert and position material and a shorter rapid welding stroke that repeats as many times as desired.

An Improved Polystyrene

REPLACING THE present Styron K-27, produced by The Dow Chemical Co., Midland, Mich., an improved polystyrene designated as Styron 411 is being offered. Such improvements as easier mold release, improved surfaces, superior welds, machinability, better flow control and elimination of the need for external lubrication are available in the new material. Buffing operations are more easily performed. In trimming, the new material shows reduction in tendency to tear back or produce a laminar condition when cut at the gate.

Switch Has Renewable Feature



RENEWABLE SWITCHES, announced by Robert Hetherington & Son Inc., Sharon Hill, Pa., are of the plug-in type in that there are two brass plugs which fit into sockets. Switches are nonsnap and are supplied complete with plug and socket. The company is also arranging to furnish its entire line of switches which run from midget size to 50 amperes at 110 volts alternating current, with this renewable feature. These include full snap switches having double-break contacts and operating at speeds from one-tenth to one-fiftieth of a second. The renewable feature will also be extended to the company's waterproof and dampproof switches which are furnished with either bellows or rubber cap.

Multiple Bulkhead Connectors

DOUBLE DISCONNECT type bulkhead connectors are particularly adapted to applications such as are found in aircraft where quick connection and disconnection of individual circuits from either side of the mounted bulkhead connector is desired. Permanent, current carrying members extend from both sides of the bulkhead part. The terminal may be connected or disconnected from the mul-

HOUGHTON IS NOW PREPARED TO SERVE ALL YOUR PACKING NEEDS

You know VIM Leather Packings, the standard for most hydraulic and pneumatic needs . . . impregnated many ways and made in all shapes and sizes. They have been leaders for many years, but they cannot be expected to cover the entire packing requirements of a plant.

For one thing, leather—even VIM Leather—will not withstand temperatures over 215° F. There are times, too, when synthetic rubber packings, or a combination of them with leather, may be needed for low pressures, although leather cannot be excelled for the higher PSI operating ranges. For example, when pressures exceeded 1500 PSI on "O" ring installations, leather washers had to be used to back up the rings, which thus supplied a perfect seal.

So, to provide a complete line, we added VIX-SYN Packings, which include fabricated and homogenous types—duck, asbestos and synthetic rubber. During the war we supplied large quantities of "O" rings and synthetic rubber "V" packings to the aircraft industry. Also, for aircraft hydraulic needs we made millions of the newer resin-impregnated leather "V" packings, the type which resisted oil so effectively on such equipment as shock struts. Now, with aviation needs fulfilled, these as well as VIX-SYN packings can be supplied to industry generally.

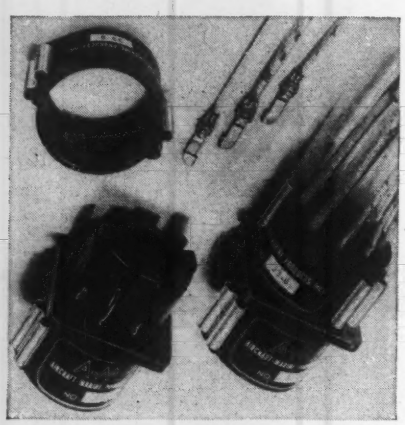
Thus Houghton has a complete line—for temperatures below zero, up to boiling point, and even up to 700° F. . . . and for all media: water, oil, air, oxygen, gases and steam.

For VIX-SYN Packings we provide complete engineering specifications, useful for your reference. Our leather line is backed by an engineering service so complete that our "Handbook on Hydraulic & Pneumatic Leather Packings" is the only complete and authoritative design manual ever prepared. If you're a packing user, ask for a copy. We suggest, too, that you make it a habit to specify Houghton Packings; they'll hold longer because they're made right, scientifically impregnated, and engineered for the job. E. F. HOUGHTON & CO., 303 West Lehigh Avenue, Philadelphia 33, Penna., and all principal cities.

HOUGHTON'S

VIM Leather and VIX-SYN Packings

tiple connector member by holding it vertically in contact with that member and then pulling back. Plastic covers snap into place over the wire connections and the entire installation can be made an airtight section of the panel



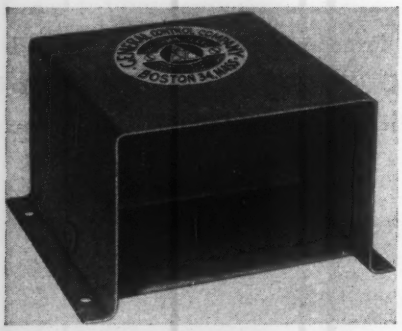
or mounting. These bulkhead connectors may be obtained from Aircraft-Marine Products Inc., 15910 North Fourth St., Harrisburg, Pa., to accommodate as many connections as desired with different combinations of wire sizes from 22 to 10, inclusive.

Composite Steel Developed

DEVELOPMENT OF a new composite steel known as Type R has been announced by Jessop Steel Co., Washington, Pa. For use in planer knives, paper knives, and blades for cutting light sheet metal, the steel is a high-carbon steel and a low-carbon steel in a composite section. This combines the hardness and edge-holding properties of a high-speed steel with the shock resistance of a low-alloy steel. Type R is available in standard sizes in even inches from 2 to 10.

Foot Switch for Light Duty

ANNOUNCED BY General Control Co., 1200 Soldiers Field Rd., Boston 34, Model MK foot switch is especially adapted for home use, light machining operations, photo printing, communications equipment, etc. Treadle is ⅛-



inch from the floor and requires ⅛-inch throw to trip the switch. Entire toe treadle is covered by a welded steel housing, thus making the model safe from accidental actuation. Made in one type with a single pole, normally open switch element, the switch has four holes in the flanged base for mounting to floor. It is finished in baked enamel.

Aluminum Treating Process

CHEMICAL TREATING of aluminum and aluminum alloys can be accomplished by a new process known as "Alumox" which has been announced by Enthone Co., Dept. MD, 442 Elm St., New Haven, Conn. It produces a corrosion-resistant coating which protects aluminum against corrosive atmospheres such as salt spray. Particularly suitable for noncopper containing aluminum alloys, the process requires no electric current. The aluminum is immersed in a diluted solution of "Alumox" salts at approximately 210 F from 2 to 15 minutes.

Retractive Extension Cord

ELECTRICAL UTILITY cords of a new type are being furnished by Koiled Kord division of Kellogg Switchboard & Supply Co., Chicago. It is a retractive, rubber-covered extension cord which can be extended to five times its retracted length. Applications include home appliances and portable tools in the industrial field.

Small Incandescent Lamps

ADAPTABLE FOR a wide range of applications including refrigerators, vending machines, instruments, etc., small incandescent lamps, rated from 6 to 10 watts are now obtainable from Sylvania Electric Products Inc., Salem, Mass. Life ratings are between 1400 and 1500 hours. Bulb designs include S-6, S-11, and S-14 types.

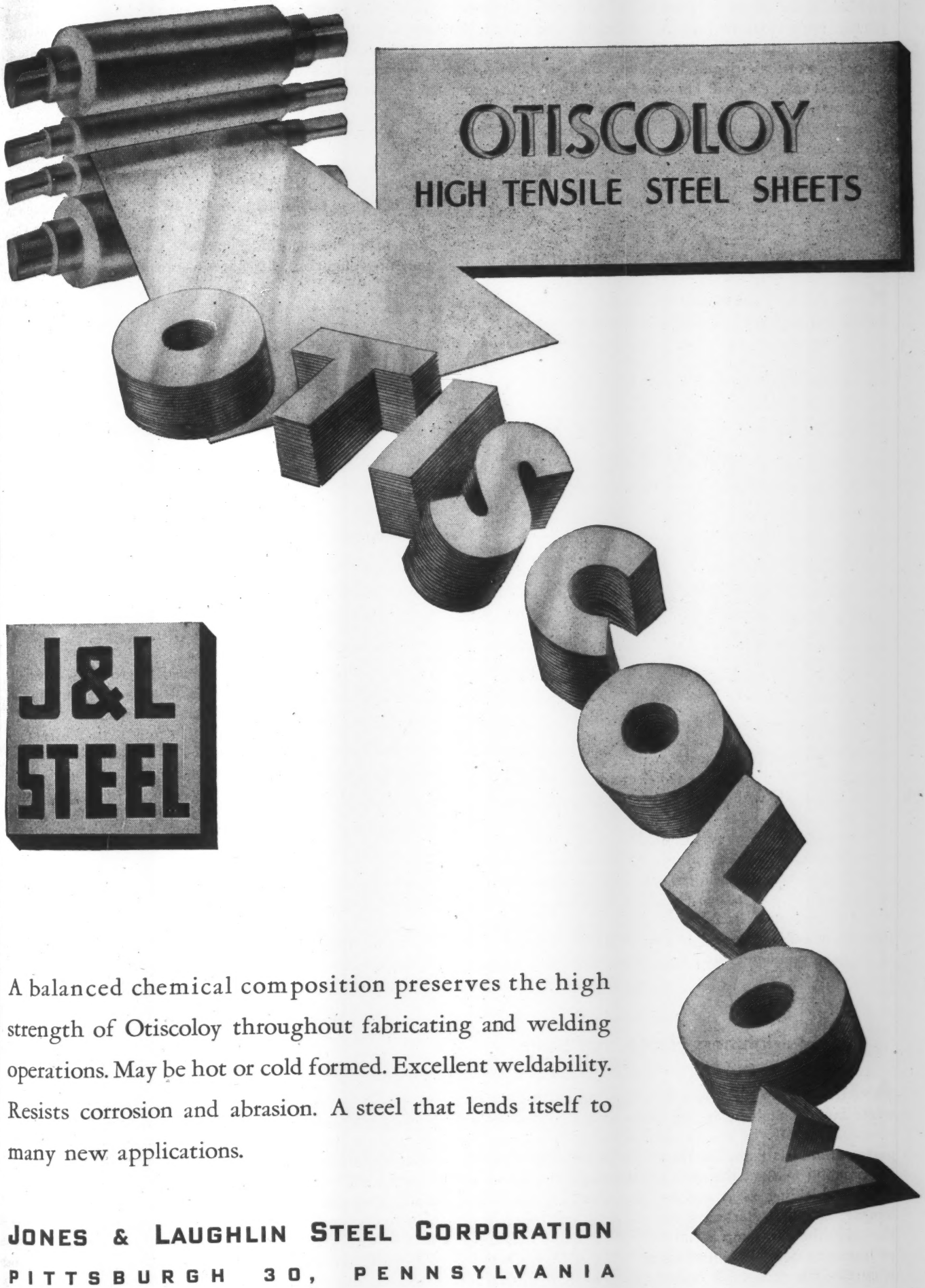
Engineering Dept. Equipment

Rough-Finish Measuring Head

NEED FOR CHECKING rougher surface finishes and waviness in metals, glass, plastics, plated and painted materials, has been met by The Brush Development Co., Cleveland, in its new rough-finish measuring head. This pickup and drive head measures irregularities from 100 to 3000 microinches, peak to valley, which extends the use and range of the company's surface analyzer from 1 to 3000 microinches.

Slide Rule of Magnesium

PRODUCED BY Pickett & Eckel, 53 West Jackson Blvd., Chicago 4, a new slide rule is being offered in lightweight Dowmetal. The rule is not affected by climatic conditions of heat, cold or moisture, and is machined to close tolerances. Self-centering "optical grooves" prevent side play



A balanced chemical composition preserves the high strength of Otiscoloy throughout fabricating and welding operations. May be hot or cold formed. Excellent weldability. Resists corrosion and abrasion. A steel that lends itself to many new applications.

JONES & LAUGHLIN STEEL CORPORATION

PITTSBURGH 30, PENNSYLVANIA

and binding of the slide. Core is surfaced with a flat white plastic, impervious to water or chemicals and practically immune to abrasion from regular use. The simplified arrangement of scales facilitates computation so that persons of limited mathematical knowledge can also evaluate and point off problems containing cube root, square root, logarithmic and trigonometric factors. The slide rule places the decimal point mechanically up to 19 digits and gives 30-inch scale accuracy for cube root, and 20-inch scale accuracy for square root.

Measuring, Inspection Instrument

KNOWN AS THE Multi-Scale Monocular, a new optical instrument recently announced by Ray Control Co., 975 East Green St., Pasadena 1, Calif., provides the means to measure and compare small objects with the aid of a six-power optical system and six selectable scales, all of which

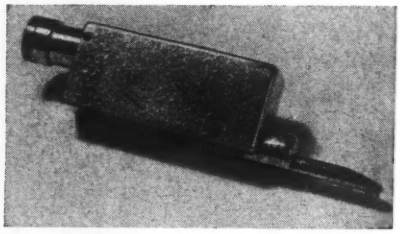
are incorporated in the instrument. The optical arrangement projects the scale selected in the plane of the subject to be observed, without the scale itself being in contact with the surface under observation. The scale desired can be brought into view by turning the outer rim of the eye cap. Having a diameter of one inch, the circular field of view is automatically in focus when the instrument stands on its base. Due to its size (height, 2 1/2 inches; diameter, 2 1/4 inches) and its relatively light weight (7 ounces), the instrument is adapted to a wide variety of uses, such as in the examination and inspection of finishes and surfaces.

Low-Brightness Fluorescent Lamp

AVAILABILITY OF a new low brightness 40-watt 4500-white fluorescent lamp in the 100-watt lamp size was announced recently by the General Electric Co. Lamp Department at Nela Park, Cleveland. It provides good quality illumination without the need for the same amount of accessory shielding as is required for standard fluorescent lamps. Having a starting stripe, running lengthwise along the tube, the new lamp is suitable for use under conditions of humidity normally encountered. The 4500-white color is particularly acceptable in drafting room lighting, and for most uses needs only longitudinal shielding. By making the new 40-watt lamp in a bulb normally used for the 100-watt lamp, slightly more than one-half of the brightness of the company's standard 40-watt, 48-inch, T-12 white fluorescent lamp has been made possible.

Profilometer Tracer

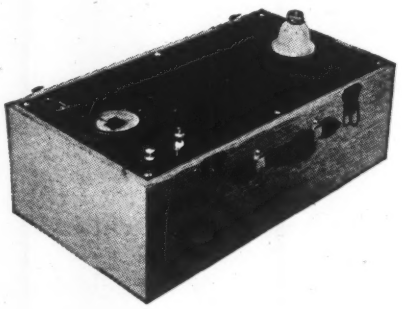
RANGE OF SURFACES on which roughness measurements can be taken has been increased by the introduction of a new profilometer tracer, by Physicists Research Co., Ann Arbor, Mich. This Type AW tracer may be used to measure roughness of surfaces on outside and inside diame-



ters down to ¼-inch. It will also measure both internal and external tapered surfaces and gear teeth. No adaptation of the equipment is necessary to use the Type AW tracer with all types of profilometers now in use.

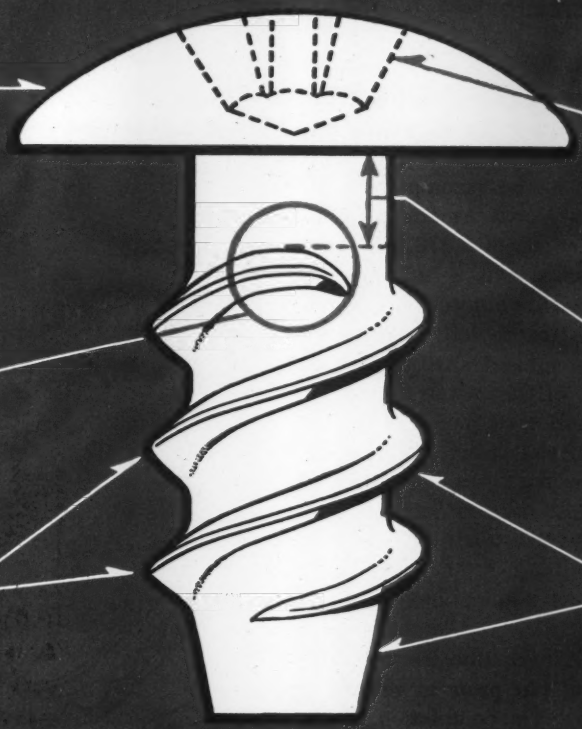
Portable Kilovoltmeter

TO ITS RAPIDLY growing line of kilovoltmeters, Shallcross Mfg. Co., Collingdale, Pa., has added its built-in Model 759 which has five ranges, providing 1, 2, 5, 10 and 20 kilovolts direct current at full scale. Accuracy of the meter is $\pm$ 2 per cent. The several new features incorporated in this instrument include a reversing switch which makes it unnecessary to change connections to the terminals of the kilovoltmeter if the polarity is reversed. If full scale accuracy better than the 2 per cent is required,



binding posts are available so that an external meter may be used. The resistance multiplier section is carefully adjusted within 0.1 per cent so that, if required, more accurate meters may be used with the external connection. This also permits the individual taps of the multiplier to be used as accurate high resistance standards. Housed in a golden oak case—10 3/16 x 10 1/2 x 10 in. —the instrument is mounted on an engraved bakelite panel.

Can you use SCRIVETS?



Any conventional head style.

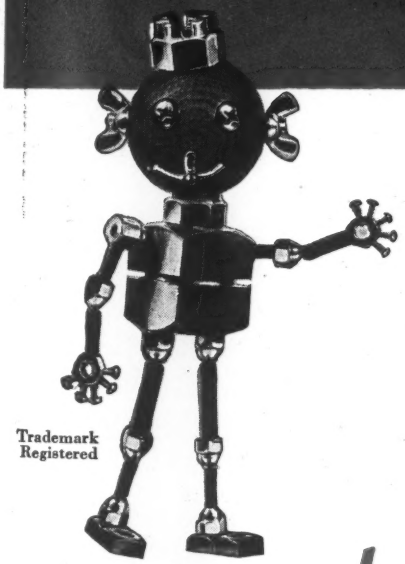
Phillips Recess, of course, for easy driving without driver slip, and self-centering for easy driving.

NEW! The final SCRIVET portion of the thread locks and permanently seals the assembly

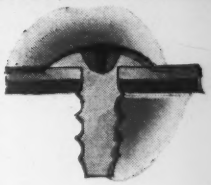
Variable to suit your requirements.

Double thread (no wobbie to the entry).

Conventional sheet metal screw thread design to enter preformed hole.



Trademark Registered



Sectional view of SCRIVET in use, showing simplest application, fastening two sheets permanently

SCRIVETS* are a new and important development in the fastening field. A sort of combination screw and rivet, the SCRIVET is driven like a screw, but it locks and can't come out. Ideal for easy, rapid and permanent assembly.

1. Holds together *permanently* any two parts or sections.

2. Replaces sheet metal screw which might work loose (the SCRIVET has better holding power than a screw).

3. Replaces rivet which is often difficult or impossible to apply in close quarters. (The SCRIVET has not quite as good holding power as a regular rivet. Holds better than a blind rivet and costs much less.)

If you see possibilities of making good use of SCRIVETS on your work, let us hear from you. We'll gladly send samples and design a SCRIVET for your special requirements.

National HEADED AND THREADED PRODUCTS

**Trademark registered. Patent Nos. 2321378, 2321379, 2353030*

THE NATIONAL SCREW & MFG. CO., CLEVELAND, O.

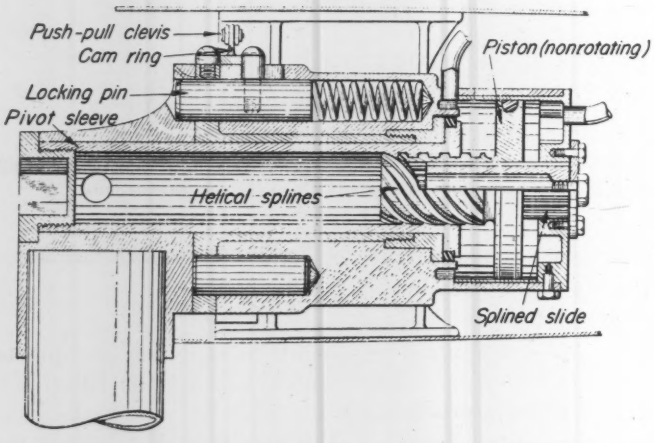
Noteworthy Patents

Hydraulic Actuator

IN MANY cases it is highly desirable to convert straight-line hydraulic power into rotative power without the use of a gear or piston motor. An actuator which embodies such an arrangement to achieve light weight, simplicity and compactness is shown in the accompanying illustration. Recently assigned to North American Aviation, Inc., the design is covered by patent 2,373,385.

Assuming that the locking pin shown is in retracted position, hydraulic fluid under pressure entering a cylinder from the right moves the piston to the left. Prevented from rotating by a fixed straight-splined shaft on which the piston slides, this movement of the piston imparts to a suitable pivot sleeve a rotary motion by means of mating helical splines on the interior of the sleeve and the external portion of the piston extension. Angular sweep of the sleeve on full travel of the piston is 90 degrees. Reversal of pressure in the cylinder returns the pivot sleeve to initial position.

Positive locking is accomplished automatically both in initial and final positions of the sleeve. Actuation of a cam ring simultaneously with the hydraulic control valve retracts the spring-loaded locking pin prior to release of hydraulic pressure to the piston. On completion of the predetermined arc of travel the locking pin, released and under influence of the spring, enters and maintains position until subsequently retracted for reversal.

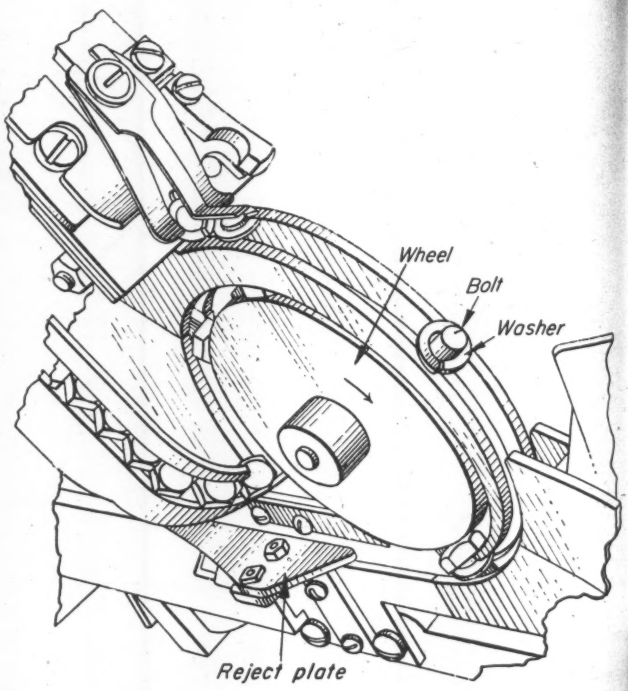


Straight-line piston movement is transformed directly into rotary movement. Maximum simplicity is achieved

Although designed primarily as a cantilever retractable landing gear strut mechanism, the actuator principle illustrated has many possibilities, especially where only a part of a revolution of movement is desired. The angular sweep of course is dependent upon the helical splines used in the sleeve.

Assembles Washer to Bolt

COVERED by patent 2,378,711 recently assigned to The National Lock Washer Co. is a mechanism which automatically feeds lock washers and bolt blanks continuously, ejecting assembled units.



Confining circular paths merge to assemble washers to bolts fed around by the wheel

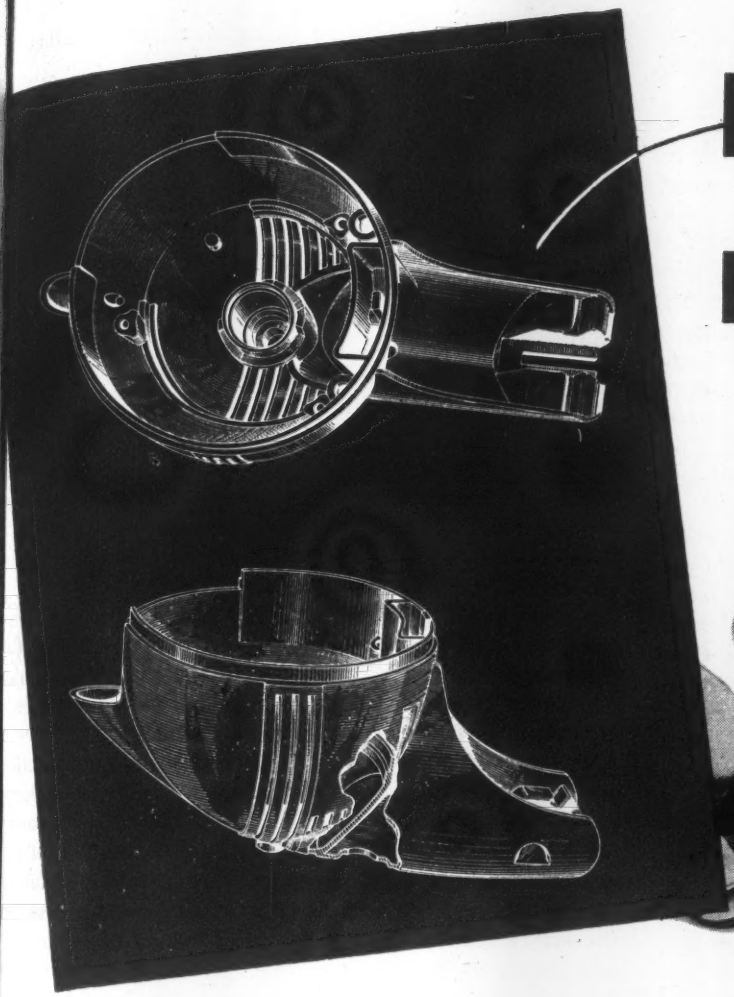
As shown in the accompanying illustration, lugs on a rotating wheel pick up bolt blanks from a gravity feed chute sliding them along a narrow circular track which confines the head and body. As the blanks are moved past a gravity feed washer chute the end of each bolt engages a tilted washer and carries it along. Passing around the circular track, washer and blank merge from their separate paths to allow ejection of an assembled unit.

A reject plate at the exit from the wheel, supports assembled units as they pass down a gravity chute to a receptacle. However, the reject plate is too high to support a blank without a washer and, unsupported, the blanks fall out into a separate chute.

Straight Ratchet

ADAPTED to operate equally well for movements of relatively large or small amplitudes, the straight ratchet and pawl mechanism shown in the accompanying

DESIGNING FOR DIE CASTING



CORED HOLES In designing die castings, do not overlook the advantages of obtaining required holes and recesses through the use of cores in the die casting die. The advantages of cored holes can be summed up as follows:

1. *Holes so formed are accurately sized and precisely located.*
2. *The quantity of metal required per casting is minimized.*
3. *Subsequent machining operations are avoided.*
4. *Cores help to keep the casting section thickness uniform.*

In the zinc alloy die casting shown here (a housing for a food mixer) the core which forms the interior of the dome also forms the ventilation slots and the other holes and recesses in the dome. Since this coring is all parallel to the die motion, the core is actually a fixed portion of the die. This type of core is the most economical, since it in no way impedes the casting operation.

There are many castings, however, which require cores at some other angle. These cores must then be movable, and provision must be made for their operation. Such a core was used to form the undercut recess in the arm adjacent to the dome in the casting illustrated. A movable core results in increased die cost and reduced casting rates, but the saving in machining frequently justifies its use, as it did in this case.

Additional data on the use of cores appears in our booklet "Designing For Die Casting." To insure that you will get the most from your die casting dollar, ask us—or your die casting source—for a copy of this booklet.

ZINC
FOR DIE CASTING ALLOYS

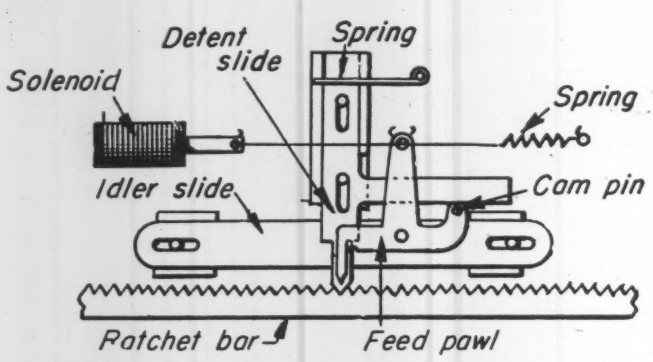
The New Jersey Zinc Company, 160 Front St., New York 7, N. Y.

The Research was done, the Alloys were developed, and most Die Castings are based on
HORSE HEAD SPECIAL (99.99+% Uniform Quality) **ZINC**

illustration may be driven at high speed, accurately and without overthrow. This design is embodied in patent 2,377,733 recently assigned to The Vitarama Corp.

Operation of the mechanism is effected by means of a solenoid, the plunger of which is directly connected to an extension of a feeding pawl pivot. A ratchet bar moved by the pawl normally is held stationary by a vertical locking detent retained by a spring. When the solenoid is energized slight frictional resistance present in the idler slide to which the pawl is attached causes the pawl to first pivot about a central pin. This pivoting action engages a cam pin on the feed pawl with a straight projection on the vertical detent slide to lift the detent against the spring and permit movement of the ratchet bar. As the detent lifts clear, the feed pawl engages a tooth of the ratchet bar to produce forward travel to the full extent of the solenoid displacement.

Forward travel of the feed pawl and idler slide retains the detent out of engagement by means of the cam pin. However, upon de-energizing the solenoid, initial return movement of the arm by means of spring tension simultaneously drops the detent and disengages the pawl. Complete retraction of the spring returns the idler slide to its original position.



Solenoid pull simultaneously releases detent lock and moves ratchet bar. Slight drag is necessary at the idler

Arrangement of the pawl and detent of the mechanism shown so as to engage the same tooth of the ratchet bar is found to be most advantageous. The pawl, however, may be located either ahead of or behind the detent where design so requires.

Lubricates Cylinder Walls

A NEW connecting rod design for V-type internal combustion engines which automatically lubricates the walls of the opposite cylinder is covered by patent 2,375,612 recently assigned to the General Motors Corp. A port in each engine crankpin lines up and discharges oil under pressure through a port in the cap of each connecting rod to spray oil against the cylinder wall opposite to that of the piston to which each connecting rod itself is attached.

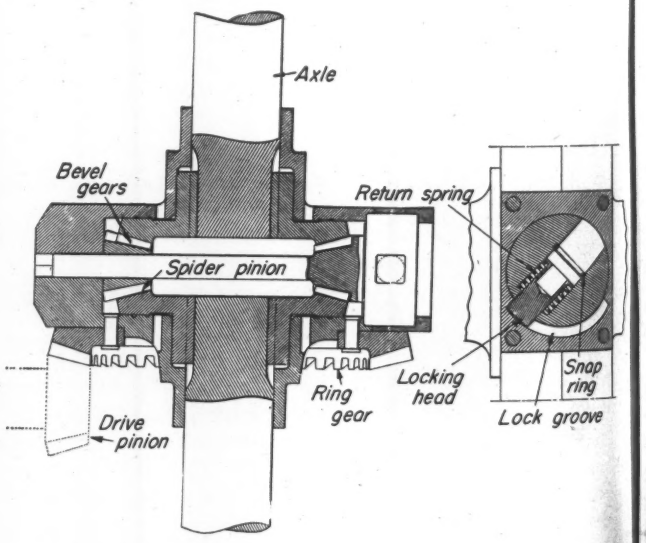
The lubrication port in the connecting rod assembly is machined into the cap face to obviate any possible weakening of the rod by an oil hole through a stressed section. A counterbore, machined at the bolt hole, provides passage from the bearing liner to a milled channel leading to the outer edge of the cap.

Differential is Self-Locking

DESIGNED to cope with and eliminate spinning of the drive wheels on heavy traction equipment operating under adverse ground or surface conditions is a new type self-locking differential covered by patent 2,387,031. Recently assigned to R. G. LeTourneau, Inc., the differential shown in the accompanying illustration automatically provides a positive non-differential drive for vehicle drive wheels when conditions so require.

When the vehicle—tractor or other heavy machine with this differential drive arrangement—is in normal operation and the axles rotate at substantially equal speeds or at a slight differential as encountered in turning, the mechanism operates much the same as do standard units. During such operation, especially when the vehicle is turning right or left, the spider pinions and pinion shaft of the differential rotate. This rotation of the pinion shaft also rotates the attached locking head which at normal speeds of operation remains inactive in the rotor.

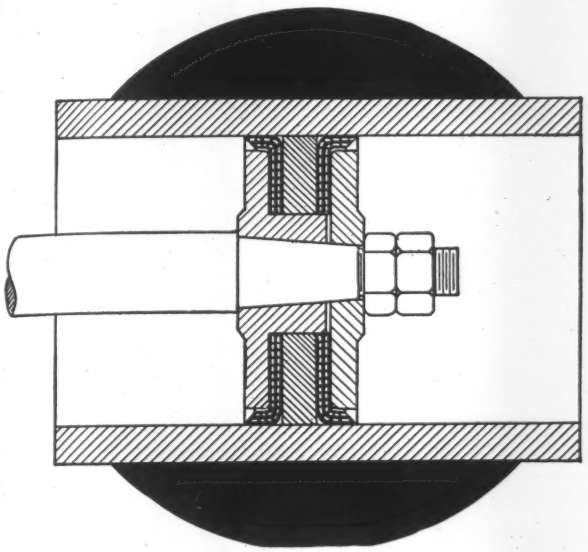
If, however, one wheel or the other loses ground traction and begins to spin as on a slippery roadway or in loose earth, the differential speed between the axles becomes relatively great and consequently the pinion shaft is rotated at correspondingly high speed. Under such circumstances the centrifugal force acting on the locking head overcomes the spring load and snaps the head out of the rotor and into engagement with a groove. Once in contact with one of the stop shoulders of the groove, the head locks the entire ring gear cage creating a positive and simultaneous drive to the axles. Adequate traction is thus assured in case of difficulty.



Centrifugal force acting on the spring-retained locking head of this differential creates a direct drive to both axles

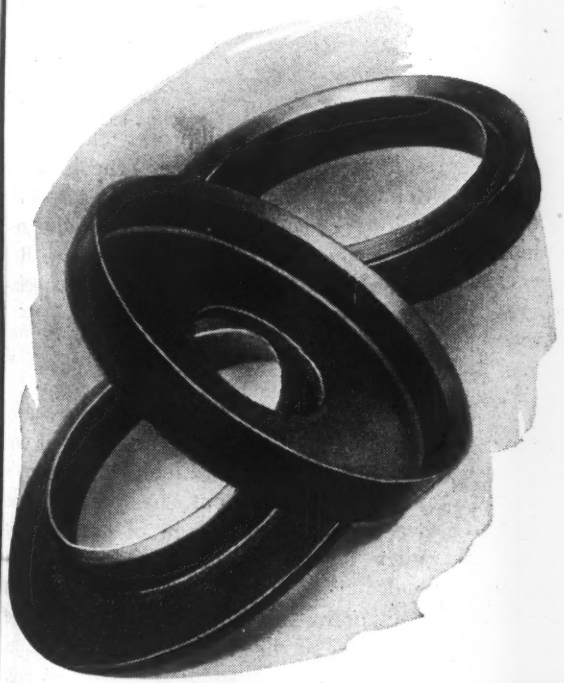
When normal differential speed between the axles is re-established the spring retracts the locking head to inoperative position and the differential again performs conventially.

WHY MACHINES DESIGNED FOR PACKING CUPS USE LESS POWER



Pumps designed to use J-M Moulded Packing Cups can often operate on less power—because these "custom-made" packings take the guesswork out of installation. They provide precision fit, minimizing both friction and slippage. Under discharge pressure, each cup functions as a tight seal. But on reverse stroke the special flexible lip relaxes, lowering friction and reducing the amount of power needed. Packing cups minimize the danger of high slippage or excessive tightness which may occur when regular type packings are installed by inexperienced hands.

AND HOW TO GET PACKING CUPS TO FIT YOUR DESIGN



You will often find it helpful, before proceeding with designs, to consult Johns-Manville on packing specifications. In this way, you will be sure of choosing packings which can be "tailored" to your needs in size, shape and composition.

In moulding Packing Cups to order, Johns-Manville varies their composition, depending on whether the cups are to seal against air, water, steam, oil, etc., or to operate against high or low temperatures or pressures. In addition, the cups are carefully moulded to particular sizes and shapes, in order to provide maximum sealing efficiency with a minimum of friction or slippage.

Johns-Manville Engineers are prepared to work with you on all Packing problems. Write for brochure PK-17A on J-M Packings for the Product Designer. Address Johns-Manville, 22 E. 40th St., N.Y. 16, N.Y.

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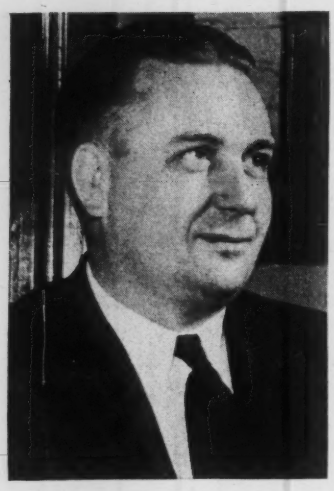
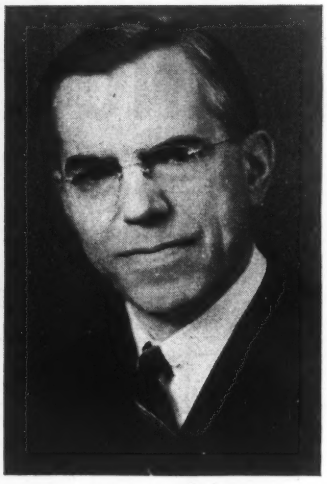
Johns-Manville ***PACKINGS & GASKETS***



R. W. McLaughlin

Dr. Wendell F. Hess



Harry A. Winne

MEN...of...machines

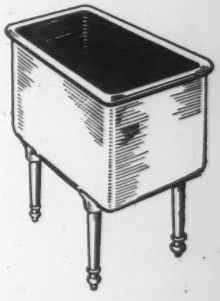
R W. McLAUGHLIN has joined Carrier Corp. as assistant director of development in charge of the heavy machinery engineering section, which includes the supervision of design and development of centrifugal compressors used in large refrigeration and air conditioning installations. Prior to joining the Carrier corporation, Mr. McLaughlin was chief engineer of the blower and supercharger division of the Elliott Co. For a period of years previous to his connection with the Elliott organization, and immediately after his graduation from Iowa State College, he was associated with General Electric in its large turbine engineering department. Mr. McLaughlin, who has a bachelor of science degree in mechanical engineering, is a contributor to engineering journals and has written numerous articles for technical magazines.

DR. WENDELL F. HESS, professor of metallurgical engineering and head of the welding laboratory, Rensselaer Polytechnic institute, has been elected president of the American Welding Society. He graduated in 1925 with a degree in electrical engineering and received his doctor of engineering degree in 1928 from the institute. Until 1930 he was instructor in electrical engineering and physics, and in 1929 also taught a course in welding to United States Navy Annapolis graduates sent to Rensselaer for special training. From 1930 to 1937 he was assistant professor of electrical engineering and physics, assistant professor in metallurgical engineering in 1937-38, and associate professor in metallurgical engineering and head of the welding laboratory from 1938 to 1945, when he was raised to a full professorship. Dr. Hess was awarded the Lincoln Gold Medal and Certificate by the American Welding Society in 1944, and also received the University Award of the Resistance Welder Manufacturers association.

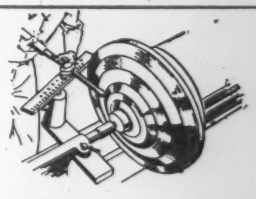
HARRY A. WINNE, who until recently had been vice president in charge of engineering for General Electric Company's apparatus department, has been made vice president in charge of engineering policy for the entire company. With headquarters in Schenectady, Mr. Winne in assuming his new duties will become a member of the president's staff, and as chairman of the engineering council will co-ordinate the engineering, scientific, and research projects of all departments and all laboratories of the company. He also will be responsible for the company's activities in connection with standards

Want a Tip?

on selecting your most practical Stainless Sheet finish

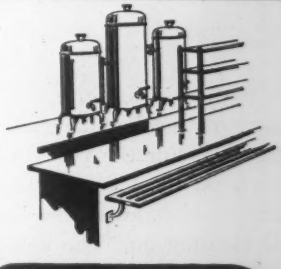


WHITE, PICKLED—No. 1 —for deep draws. Tanks, bins for chemicals—the dough trough shown at the right —heavy duty industrial equipment—applications in which stainless works with its sleeves rolled up.



DULL, SMOOTH—No. 2D —for forming, drawing, dishing —*and spinning.* Mild cold finishing has rendered the surface smooth and dense. Tools ride easily over the surface. Stainless shapes itself to your product—and your needs.

BRIGHT, DIFFUSELY REFLECTIVE—No. 2B —for formed products where "look" is a factor. Painstakingly rolled and inspected for perfect uniformity of surface, 2B calls attention to itself. And where special sheens and lusters are required, 2B can be brushed or polished after fabrication.



POLISHED, SATIN, REFLECTIVE—No. 4 —one of the most dramatic of stainless finishes—and the easiest to keep clean. The finish for food service equipment, decorative trim, dairy equipment — wherever it pays to boast, "This is stainless." JML Co B-M1

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and the co-ordination of matters relating to recruiting, education and transferring between company units of all engineering personnel. Mr. Winne joined the company as a student engineer in the testing department upon his graduation from Syracuse university with an electrical engineering degree in 1910. The following year he became head of the large motor, generator and synchronous converter test, and subsequently assistant general night foreman of the testing department. Six years later he was promoted to the power and mining engineering department, now known as the industrial divisions, working on industrial heating, arc welding, and electric furnace equipment. In 1922 he was assigned to the steel mill section of the industrial engineering department, becoming its head in 1930. Until 1937 he was sales manager of the combined mining and steel mill section, when he was named assistant to the engineering vice president. In 1941, Mr. Winne was elected vice president in charge of apparatus design engineering, and in January 1945 he was appointed manager of engineering, the post he now vacates.

♦

RAYMOND W. YOUNG, since 1940 chief engineer of Wright Aeronautical Corp., has been elected vice president in charge of engineering. After graduating from Yale university in 1925, Mr. Young joined the Wright corporation, and as chief engineer directed development of the original Wright Cyclone 18, first aircraft engine to attain 2000 horsepower. Mr. Young, a recognized authority on aircraft engines, also has contributed to the development of a turbo-supercharger to solve specific problems of high horsepower and high altitude operations. About a year ago, Mr. Young ushered the Wright organization into the field of aircraft gas turbines. He is vice president of the Society of Automotive Engineers, a member of the Institute of Aeronautical Sciences and has received several awards for his contributions to aircraft power plant design.

♦

PROF. G. L. TUVE has been made head of the department of mechanical engineering, Case School of Applied Science. For the past two years Professor Tuve, who has been on the Case faculty since 1930, has been chairman of the Committee on Research of the American Society of Heating and Ventilating Engineers.

♦

R. C. GREGG has joined the engineering staff of Bryant Heater Co., Cleveland. Formerly he had been assistant chief research engineer of the American Gas Association testing laboratories.

♦

C. L. COMEGYS has been promoted to manager of the research and service division of Addressograph-Multigraph Corp. In his new position he will supervise and coordinate all research and service activities of the company, including mechanical development, field research, chemical research and development, etc.

♦

WILLIAM G. BOSTWICK, previously chief electrical engineer of Federal Machine & Welder Co., has joined the Precision Welder & Machine Co., Cincinnati, in the same capacity.

♦

JOHN C. LUTTRELL has joined Northeast Airlines Inc., East Boston, Mass., as director of engineering. He had been assistant project engineer, American Airlines Inc., as well as chief engineer of materiel maintenance, project section, headquarters, Air Transport Command, Gravelly Point, D. C.

♦

EDWARD P. RHODES JR. was recently named assistant chief engineer, Ryan Aeronautical Co.

♦

GEORGE SPATTA, formerly vice president and general manager, has been elected president of Clark Equipment Co., Buchanan,Mich. Known in automotive circles for his achievements, Mr. Spatta was responsible for many developments of the company. Since joining the organization in 1927 he had successively served as development engineer, chief engineer, general manager and vice president.

♦

ROBERT E. BUSEY has been promoted from development engineer to executive White Horse engineer of White Motor Co., Cleveland; THOMAS S. KEMBLE, from project engineer to development engineer; RUDOLPH LISCH from chief draftsman of the general engineering department to senior chief draftsman of the same department; C. A. MILLER, from assistant chassis engineer to axle design engineer; and VIRGIL C. SPEECE, from truck production engineer to executive truck engineer.

♦

DAVID J. LITTLE, previously chief aeronautic engineer, Hartwig Aircraft, San Antonio, Tex., is now serving as a design engineer with the Detroit Gear Aircraft Div., Borg-Warner Corp.

♦

EVAN S. PIRCHARD has resigned as chief engineer of Tricoach division, Pacific Car & Foundry Co., Renton, Wash., to become affiliated with the Cook Bros. Equipment Co., Los Angeles, in the same capacity in the company's equipment division.

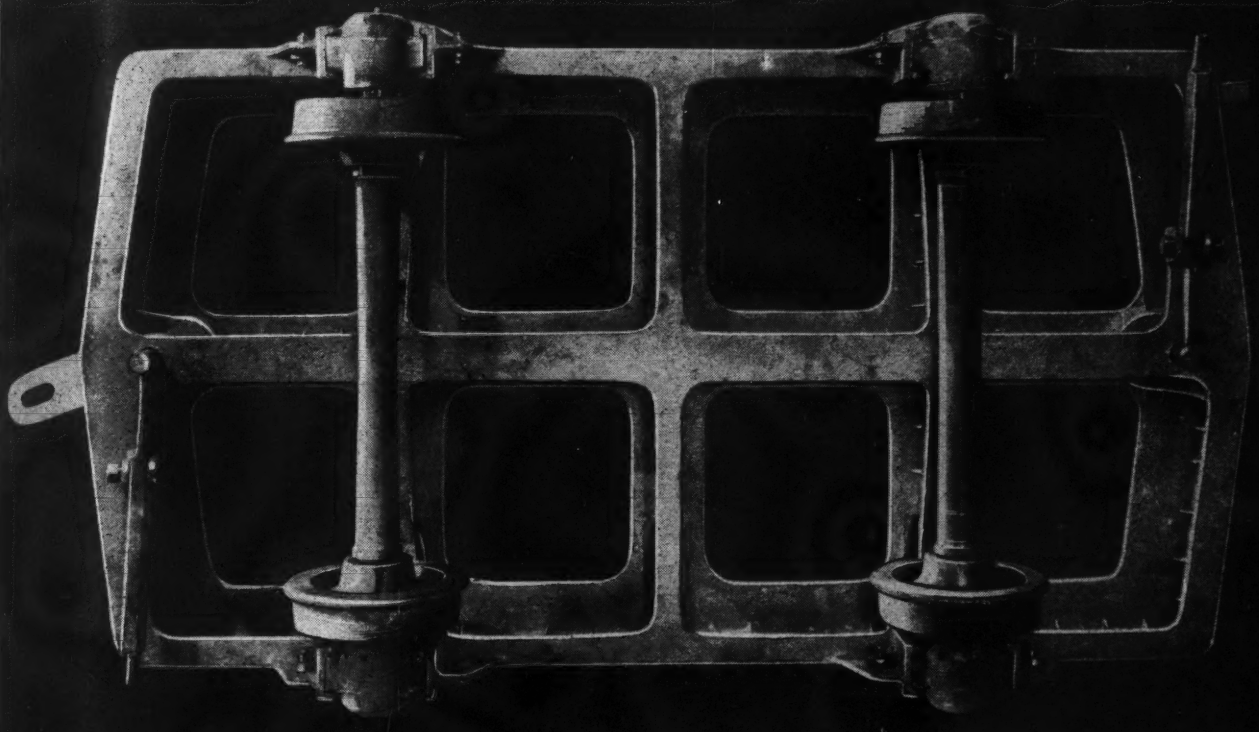
♦

GARRARD MOUNTJOY has been advanced to take charge of all research and development work in the New York laboratories of Lear, Inc. He had been in charge of research and development work in the radio division of the company.

♦

HERBERT B. NOTTAGE is the new research associate on the staff of the Research Laboratory of the American Society of Heating & Ventilating Engineers. A graduate mechanical engineer, Mr. Nottage has most recently been connected with Pratt & Whitney Aircraft, East Hartford, Conn., as a member of its research and development engineering staff, working on problems in thermodynamics, heat transfer and fluid mechanics.

STEEL CASTINGS BY PSF...



—and **DESIGN** *by* **PSF**

PSF Steel Casting Service is *complete*, as well as top-quality. We not only produced the open hearth charging-box car, above, but also developed the design—calculated to give improved operating qualities and life. What's more, we have all of the facilities to supply castings fully machined and assembled, if you desire. ● Let us figure on *your* requirements—any size, carbon or alloy steels.

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ASSETS to a BOOKCASE

Experimental Stress Analysis
Vol. II No. II

Edited by C. Lipson, Chrysler Corp. and W. M. Murray, Massachusetts Institute of Technology; published by Addison-Wesley Press, Inc., Cambridge, Mass.; 166 pages, 8½ by 11 inches, clothbound; available through MACHINE DESIGN, *$5.00 postpaid.*

Containing the study and development of new techniques for the determination of stress and strain in machines, this book represents the work of the many authors whose papers were presented at the latest meeting and symposium on crankshaft stresses held in Cleveland by the Society for Experimental Stress Analysis.

Covered in this volume are the design and application of a magnetic-coupled torquemeter for measuring stresses in rotating equipment, determination of loads in riveted and spotwelded joints, a study of residual stresses as they affect fatigue resistance, and the use of electronic measuring devices for improvement in engineering design. Of particular interest to machine designers is the section covering the structural evolution, metallurgy, processing, and determination of operating loads and stresses of crankshafts.

□ □ □

High-Frequency Induction Heating

By Frank W. Curtis, consulting engineer, Induction Heating Corp.; published by McGraw-Hill Book Co. Inc.; 235 pages, 5¼ by 8¼ inches, clothbound; available through MACHINE DESIGN, *$2.75 postpaid.*

Designers of machines having parts which require some method of selective or zonal heating—for heat treating, hardening, brazing, annealing, stress relieving, forging, or similar operations—will find in this book some of the many possibilities for more efficient, more uniform, more economical production of such items through the use of high-frequency induction heating. Once the proper application is understood and a knowledge of limiting factors analyzed, many of the practical advantages of this method over other forms of heating are readily apparent in rapid, accurately controlled localized heating with high-production possibilities and lower costs.

A sound knowledge of what induction heating can and cannot do, though relatively simple, is basic to its practical application. The author—a specialist in this field—presents a thorough-going overall picture of the high-frequency induction method, covering basic electrical principles involved, applications and limitations, heating-coil design, joining of metal parts, and hardening or heat treating. Particular stress is placed on the influence of induction heating on machine parts. The author gives many practical design "kinks" and adaptations which should help to utilize most effectively this versatile production heating method.

□ □ □

Piping Handbook

By Sabin Crocker, senior engineer, Engineering Division, The Detroit Edison Co.; published by McGraw-Hill Book Co. Inc., New York; 1376 pages, 4½ by 7 inches, clothbound; available through MACHINE DESIGN, *$7.00 postpaid.*

Well known in engineering circles as an authoritative and highly informative reference work for those interested in piping design, this latest edition offers an even greater coverage than previous volumes. Covering the use of piping in all of its engineering and industrial applications, the book represents a vast compilation of data drawn from a great many sources. Steam and power plant piping, heating and plumbing systems, oil and gas piping, etc., as well as materials, design, installation practice, construction details, cost analyses, and dimensional standards are adequately dealt with.

Of special interest to machine designers is a new chapter on hydraulic power transmission piping which covers elements and principles of hydraulic systems, pumps, hydraulic fluids, valves and fittings.

Highly interesting and informative, a book entitled "High-Pressure Die Casting—A Design Guide for Engineers" emphasizes the design aspects of die casting rather than the analysis of the end use of parts so produced. As a brief introduction, the history of die casting and the process in general are discussed as well as the common metals used in production. Types of dies and their varying degrees of complexity are also covered as well as the relationship of casting design to die design.

Further chapters deal with pressure-mold castings having exceptionally high physicals, simplified methods of machining, finishing, and inspecting. In conclusion, typical case histories of a number of parts are outlined indicating the important design factors. Authored by H. L. Harvill, president of the H. L. Harvill Mfg. Co., and Paul R. Jordan, industrial consultant on die casting, the book is clothbound and contains 130 pages, 7 by 10 inches. Published by the H. L. Harvill Mfg. Co., Los Angeles, Calif., it is available directly at $5.00.

HERE it is . . . the new Klearking Filter . . . a product of Empire Distributors of Chicago. It is easily attached to any faucet and, by means of a special filter disc, yields clear, sparkling water free from sediment and chlorine taste. And, thanks to CMPC Molded Plastics, the low production cost places the unit within the easy reach of everyone.

Molds were made and the plastics parts molded of a polystyrene material having extremely low moisture absorption, successfully resisting the effects of hot water at faucet temperatures. They are immune to rust and corrosion and consequently there is no danger of contamination. And the filter is available in a wide variety of attractive colors to harmonize with any kitchen color scheme . . . colors that will retain their sparkling beauty indefinitely.

This is another example of CMPC Complete Service . . . designing, mold-making, molding, and finishing . . . the ability and the facilities for handling any plastics molding job from the simplest to the most complex . . . a service that is backed by more than a quarter century of experience in plastics. And that's another reason why you'll find this a good place to bring your plastics molding problems.

Why not ask for the services of a CMPC Development Engineer? There's no obligation.

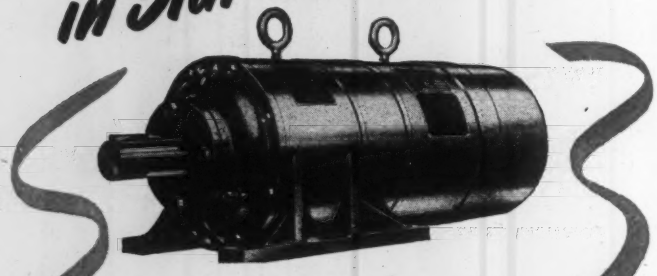
CHICAGO MOLDED PRODUCTS CORPORATION

1028 N. Kolmar Ave. Chicago 51, Illinois

Branch offices in principal industrial centers

COMPRESSION AND INJECTION MOLDING OF ALL PLASTIC MATERIALS

There's Extra Stamina in Star GEARMOTORS



Star solved a problem for a well known user by designing this Gearmotor with Built-in Brake.

Check the reasons why Star Gearmotors are often preferred for punishing services. Users will tell you – "because a Star gives us both heavy-duty construction *and* an unusual combination of design improvements that mean plenty in terms of efficiency and all-'round convenience".

Star Gearmotors will live-up to such praise. Small units are built on a heavy-duty basis. All ratings are made extra-strong throughout. Many users will tell you that a Star's extra-stamina gives them an ample margin of safety to meet unexpected strains . . . often removes the need to use a larger size merely to be "on the safe side".

CHECK THESE FEATURES . . .

✓ **1** Center spacing of gears is constant . . . no need to change parts other than gears to change speed ratios.

✓ **2** Integrated design avoids a coupling between gear unit and motor . . . promotes compactness and simplicity.

✓ **3** Motor pinion of highest grade alloy steel is pressed and keyed into motor shaft.

✓ **4** All motors have anti-friction bearings . . . ball or roller bearings according to the reduction step.

✓ **5** Long life is insured by the use of gears of liberal size giving low tooth pressure.

✓ **6** Motor, gears, everything is made by Star. Complete control of manufacture assures accuracy and uniform quality.

✓ **7** Where a mounting problem cannot be solved with standard types, Star's welded steel construction permits a solution at reasonable cost, and prevents delay.

✓ **8** Wide flexibility is found in a complete line of AC and DC Gearmotors, all cycles, phases, and voltages. Planetary gear and parallel shaft ¼ HP to 75 HP, speed reduction ranges from 2½ to 1 up to 100 to 1. Right angle worm gear reduction units up to 7½ HP. All types available with Star built-in disc brakes.

If you're particular about gearmotors, we suggest close analysis of Star Gearmotors for your product or plant. For more facts, write – Star Electric Motor Company, 220 Bloomfield Avenue, Bloomfield, New Jersey.

STAR MOTORS

POWER PACKAGED AS YOU NEED IT

Transition Briefs

A FAR STRONGER AMERICA which more than doubled its industrial output in a record-breaking five-year expansion for war "is already well along the road toward solving the challenging problems of the transition to a peacetime economy", said J. A. Krug, Chairman of WPB in his report on wartime achievements and the reconversion outlook.

MORE HORSEPOWER and fewer horses on American farms will mean an annual demand for nearly 250,000 new tractors for the first five postwar years. This is about 10 per cent higher than the average for the last five prewar years. The B. F. Goodrich Co. bases this estimate on a survey of farm vehicle tire sales prospects.

PERSONAL PLANE MANUFACTURERS are setting up production facilities and formulating sales plans in anticipation of doing close to $100,000,000 business in the coming year, according to Continental Motors Corp. This value is based upon 35,000 to 40,000 light planes and would mean building about 60 per cent more personal planes than were in existence before the war.

JOB SECURITY and rapid up-rating of workers are the principal labor inducements with which the foundry industry expects to recruit additional manpower to offset current lag in castings production. Current castings production is now running at a 9,000,000-ton annual rate and must be lifted to about 12,000,000 to meet reconversion demands, according to WPB.

TWO BILLION DOLLAR construction program of the Bell System involves the purchase by Western Electric of property for the construction of a new electronic components plant at Allentown, Pa. The plant when operating at capacity will employ about 1500 people. Manufacture will include vacuum tubes, quartz crystals, temperature sensitive devices and other precision products.

PROBLEMS OF SPEEDING peacetime production by making use of the newest methods of high-frequency heating may be brought for study by all western industry to a new laboratory opened by Westinghouse in Los Angeles. Radio-frequency heating, either induction or dielectric, will be developed at this lab.

TWO MILLION DOLLAR expansion program has been started at the Trenton plant of the Panelyte Division of St. Regis Paper Co. to meet the pressing demand for increased volume and quick delivery of molded and fabricated parts used by the refrigerator industry.

BY THE END OF THIS YEAR, barring production interruptions, the Borg-Warner Corp. will be producing at a pace to meet all demands in the automotive, aviation, and agricultural fields and will be geared to increase its output in household appliances and other lines. During the next two years the company plans to spend more than 20 million dollars for reconversion, plant improvements and expansion.

O.K. of a Great Critic...

A WHOLE PLANTFUL OF THEM WHO BUILD MOTORS TO SATISFY EXACTING BUYERS!

Other plants may turn out *more* motors than the Star Plant. But you'll find no *better* motors . . . for when you see the Star Trademark you see the "O.K." on the efforts of hundreds of meticulous craftsmen working to critical standards.

Among them are the men who own the company. For Star's owners are born motor men, and the place to find them is out in the plant or around a drawing board, helping to make Star Motors as good as they can be.

Everybody at Star is exacting about quality . . . in design, materials, workmanship. There's a craftsman's spirit everywhere that words can't cover. But motor buyers who visit us always comment on it. And exacting motor users recognize that Star does things a bit better by specifying Star where a motor must be better than "good enough".

WRITE FOR 8-PAGE DIGEST. It outlines Star Motors (⅛ to 200 HP) and Generators (to 150 KW) . . . names hard-to-satisfy buyers who are long-time customers . . . tells how Star becomes the "Motor Department" for customers. Star Electric Motor Co., 220 Bloomfield Ave., Bloomfield, New Jersey.

STAR MOTORS

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Low in sensitivity to ordinary electric light, Photo-Arc can be printed in a normally lighted room — even in your drafting room.

Peerless Photo-Arc reproductions speed up new products

Now you can make any type of contact photo-reproduction with new ease, new speed, new standards of quality:

- Black line reproductions from pencil originals
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Moreover, every kind of Photo-Arc reproduction can be made on your blueprint machine.

Or, you can obtain a Photo-Arc printer at surprisingly low cost.

For further information write for Bulletin 14F

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PEERLESS PHOTO-ARC REPRODUCTION PAPERS

BUSINESS AND SALES BRIEFS

ACCORDING to a recent announcement by Allen-Bradley Co., Charles B. Pickering has joined the Boston office as sales engineer. In his new position Mr. Pickering will serve the New England territory as application engineer for the company's solenoid motor controls.

♦

Wickwire Spencer Steel Co. has named L. R. Austin as distributor for its wire rope in Montana, Wyoming and Idaho. Mr. Austin's headquarters and main sales offices will be located at Billings, Mont. Wire rope for oil fields and other industries will be stocked at Billings and Cut Bank, Mont., and at Casper, Wyo.

♦

Formerly manager of transformer sales for the Line Material Co., O. M. Hullinger has been appointed manager of the Chicago office of Elastic Stop Nut Corp. of America, and will make his headquarters at 20 North Wacker Drive.

♦

Opening of a New York City sales office at 475 Fifth Ave., has been announced by The Beryllium Corp. of Pennsylvania. Thomas F. Davis has been placed in charge as district manager. Formerly he had been chief metallurgist of the Philadelphia Works of General Electric Co.

♦

Recently returned from the armed services, Louis F. W. Stuebe has rejoined the Chicago sales engineering staff of the Hyatt Bearings Division of General Motors Corp., and will specialize in Hyatt railroad applications.

♦

Acquisition of the business of Certified Gauge & Instrument Corp., Long Island City, N. Y., has been announced by American Chain & Cable Co. Inc., Bridgeport, Conn. Henceforth the newly acquired company will be known as Helicoid Gage Division, American Chain & Cable Co. Inc.

♦

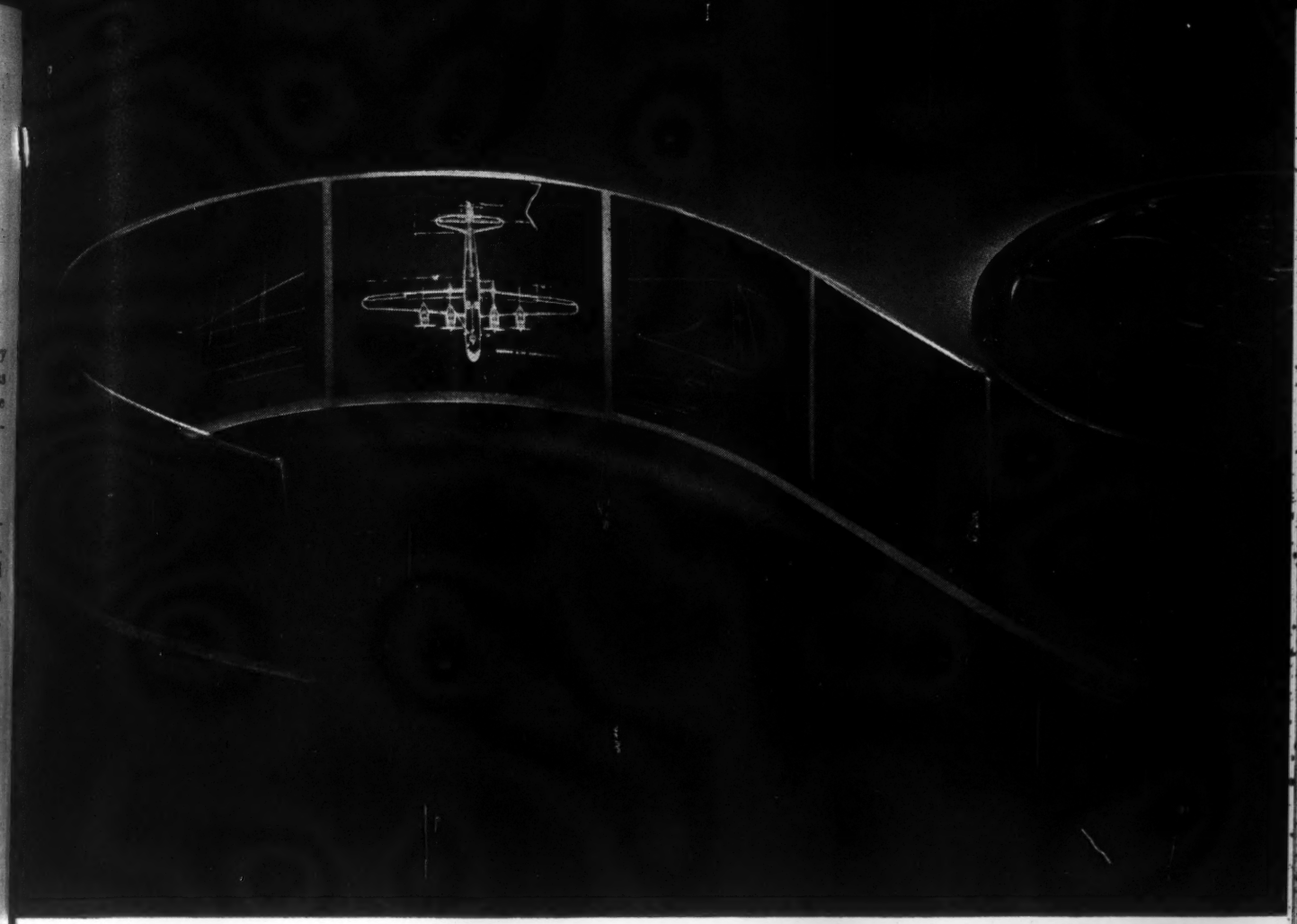
With headquarters in the Gary National Bank Bldg., Harold J. Thompson has been appointed district manager in Gary, Ind., for Reliance Electric & Engineering Co. He will serve the industries of the Calumet and northern Indiana districts.

♦

Succeeding the late Harry M. Swigart is George H. Fobian as president of The Oilgear Co., Milwaukee. Previously Mr. Fobian had been vice president and director of the company.

♦

Briggs Clarifier Co. recently has appointed three distributors: Weeks Engineering Co., 4526 Olive St., St. Louis, has been named industrial products distributor for eastern Missouri, a part of southern Illinois, and a part of southern Indiana. Principal trading centers include St. Louis, Springfield and Quincy, Ill., and Terre Haute, Ind. Curtis Engine & Equipment Co., 104 Light St., Baltimore, has been appointed marine products



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Protect war drawings and records . . . file on space-saving, tamperproof microfilm . . . with Recordak!

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Recordak copies photographically—with the speed of light. It reproduces even big drawings on tiny microfilm. For reference or checking, images can be projected quickly in a Recordak Reader. Enlarged prints can be made from the negatives.

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19

distributor for the Chesapeake Bay area, which includes all Maryland counties bordering the Chesapeake Bay. Equipment Supply Co., 60 Richards St., Salt Lake City 1, Utah, has become a franchised distributor for Briggs industrial oil filtration products in Utah; Unita County, Wyoming; the southern half of Idaho, and a portion of eastern Nevada.

♦

Having served three years in the Army, George E. Victor has resumed his former position as executive vice president in charge of production for Victor Mfg. & Gasket Co., Chicago.

♦

Opening of a new office in Cleveland at 206 Plymouth Bldg. has been announced by Willis Engineering Co., Ohio distributor of the industrial oil filtration products of Briggs Clarifier Co. General offices of the Willis company have been moved to Burton, O.

♦

Formerly with Western Electric and Wickwire-Spencer Metallurgical Co., J. W. Forbes has been named sales manager of Cleveland Tungsten Inc., and will make his headquarters in Cleveland.

♦

Announced recently by Gerotor May Corp., Logansport, Ind., is the appointment of Garco Machinery Co., Cleveland, as representative in that territory for Gerotor air and hydraulic valves and cylinders, and hydraulic pumps.

♦

Construction of a new plant at Troy, N. Y., has been started by the Marshall-Eclipse Division of Bendix Aviation Corp. in order to meet expected demands for brake linings for postwar passenger cars and trucks. All fabricating and manufacturing will be done in the new plant, which will be four times larger than all the present buildings of the division.

♦

According to a recent announcement by American Roller Bearing Co., Pittsburgh, William G. Succop has been elected president to succeed his father, the late Clarence F. Succop. Previously Mr. Succop had served the company for several years in sales and administrative capacities. In addition to his position as general manager, Carl Knaak has been elected executive vice president.

♦

The Carpenter Steel Co., Welded Alloy Tube Division, Kenilworth, N. J., has made the following appointments in order to facilitate distribution and sales of stainless steel tubing: F. A. Guba, eastern manager of sales operating from the Kenilworth office, and F. D. Archer, midwestern sales manager operating from the Chicago office at 221 North LaSalle St.

♦

Election of E. J. Fullam as president to succeed the late E. R. Fellows has been announced by The Fellows Gear Shaper Co., Springfield, Vt. Associated with the company for more than forty-seven years, Mr. Fullam most recently served as vice president.

♦

Among other appointments made by Precision Castings Co. Inc. are the following: Lester H. Pillion, connected with the die casting industry for over thirty years, has been named eastern sales manager with offices in the Chrysler Bldg., New York 17. Associated with the company for the past twenty-five years in a sales capacity, Ross W. Castle has been appointed western

LONG LIFE • SATISFACTORY PERFORMANCE

Quick-As-Wink
LEVER OPERATED
HYDRAULIC VALVES

The valve illustrated is a 3-way hydraulic valve with steel body and stainless steel plungers.

2-way, 3-way and 4-way hydraulic valves, both hand lever and pilot cylinder operated are available for pressures as high as 5,000 pounds per square inch.

C. B. Hunt & Son, Inc., also manufactures a complete line of 2-way, 3-way and 4-way air valves for pressures up to 250 pounds per square inch. These are made for hand, foot, diaphragm, solenoid and pilot cylinder operation, as well as for other mechanical actuation.

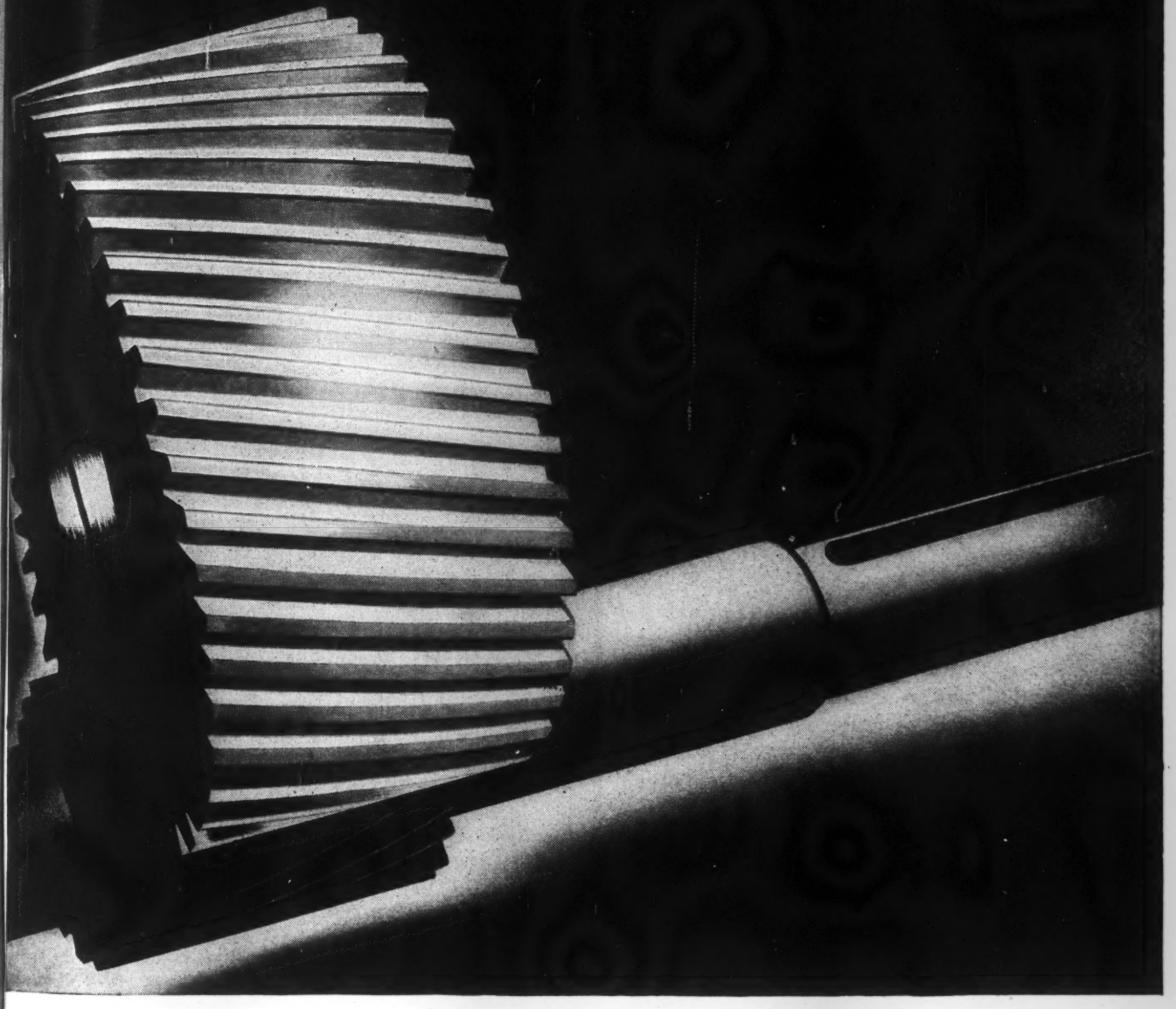
The Hunt catalogue contains engineering charts for help in selecting suitable pipe and valve sizes.

THE HIGHER THE PRESSURE
AIR
WATER
OIL
THE TIGHTER THE SEAL

C. B. HUNT & SON, INC.

1854 EAST PERSHING STREET • • • • SALEM, OHIO

Molybdenum gives steel the strength and toughness necessary to make long-lived gears.



CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

ARMY E NAVY

MOLYBDIC OXIDE, BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

Climax Molybdenum Company

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MOLY

POWER CONNECTORS

Strong...
Tough...
Flexible...

NORGREN INDUSTRIAL

HOSE ASSEMBLIES

assure greater machine efficiency by delivering a full flow of power to your hydraulic and pneumatic equipment at all times. Impervious to heat, cold and solvent; resistant to oil and grease. Constructed of tough synthetic rubber hose reinforced with two layers of braided high tensile steel wire. Won't rot, kink or slough off to clog machine.

Resist continuous vibration. Flex almost indefinitely without failure. Withstand working temperatures of —40° to 250° F.

For years of trouble-free service specify Norgren Hose Assemblies. Available 1/4" to 1" I. D., any length. Permanent couplings for high pressures, re-usable couplings for low pressures.

Ask for Bulletin 450. C. A. Norgren Co., 220 Santa Fe Drive, Denver 9, Colorado.

Norgren

sales manager with headquarters at the Cleveland plant, 12600 Berea Rd.

♦

Under the direction of Charles A. Thompson, new offices have been opened by Robins Conveyors Inc. in the Brown-Marx building, First Ave. and 20th St., Birmingham, Ala. Mr. Thompson will work with the company's agents in all southern states east of the Mississippi river. Prior to the war he had been sales engineer in the Pittsburgh office.

♦

Appointment of Leonard C. Doolittle as industrial hose sales engineer has been made by The Weatherhead Co., Cleveland. Mr. Doolittle will head a new division specializing in the sale of industrial hose and hose couplings.

♦

With headquarters in Hartford, Conn., Carle W. Blade has been named carbide representative in the southern and western Connecticut territory of Firth-Sterling Steel Co. He has been associated with the sale and use of sintered carbides for sixteen years.

♦

Ralph W. Payne has been appointed southern representative on railway specialties, general castings and machine work for Pittsburgh Steel Foundry Corp., Glassport, Pa. His offices are located in the Metropolitan Bank Bldg., Washington, D. C.

♦

According to a recent announcement by Standard Varnish Works, Landon Browne has been named technical sales representative in upper New York and northwestern Pennsylvania.

♦

To aid users of the SR-4 strain gage, the Southwark Division of Baldwin Locomotive Works has placed the following field sales engineers in five of its branch offices: Richard Hannon, Boston; Joseph Farley, Chicago; Robert Cleeland, New York; Glenn Rowell, Philadelphia; and Stanley Zansitis, Detroit. SR-4 sales manager at the Eddystone, Pa., office is Jordan H. Gaul.

♦

Election of N. F. Adamson as vice president in charge of sales and engineering has been announced by The Twin Disc Clutch Co. Previously he had been general sales manager.

♦

Recently made known by C. P. Clare & Co., Chicago, is the appointment of D. R. Dooley as vice president in charge of sales. Prior to his appointment Mr. Dooley had been associated with Automatic Electric Sales Corp. as assistant sales manager.

♦

Hercules Powder Co. has announced plans for a new plastics laboratory at its Parlin, N. J., plant. Serving as headquarters for development and research work on plastics, the laboratory will be used for conducting tests on ethyl cellulose, cellulose acetate, and nitrocellulose. Chemists will aid in developing new applications and in helping to find answers to customers' production problems.

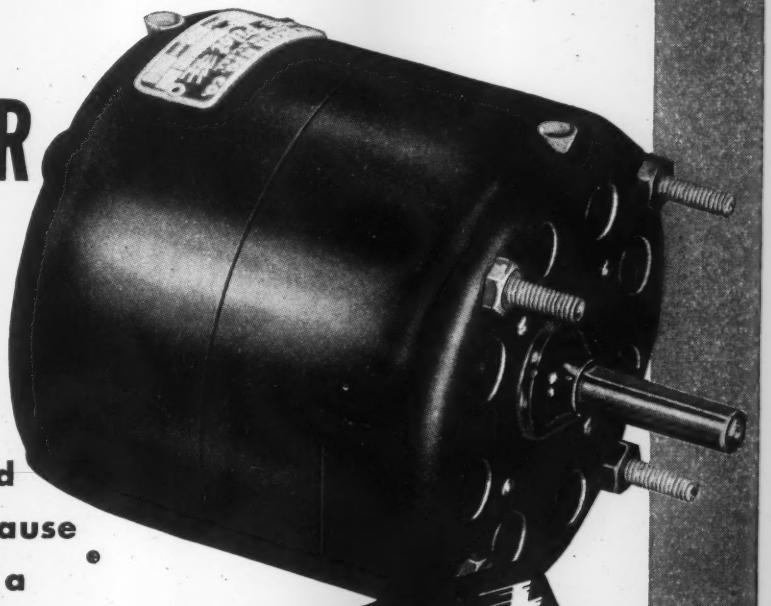
♦

Addition of the following district office representatives to its engineering staff has been made by The Lincoln Electric Co., Cleveland: John A. Smithers, welding engineer in the Detroit area; W. L. Herbst, welding engineer at the Chattanooga, Tenn., office; Harold H. House, welding engineer in the Moline,

THIS NEW MOTOR

WILL NOT BE AVAILABLE UNTIL MID-'46 BUT...

we feel that you should know about it now because the right time to apply a motor is while your product is still in the planning stage.



Pilot
Fractional H.P.
MOTORS & BLOWERS

It's a two-pole shaded pole unit with new levels of efficiency... This is how it performs—

HORSEPOWER 1/30

Full Load R.P.M.	3050	No Load R.P.M.	3500
Full Load Watts	95	No Load Watts	61
Full Load Amps.	1.25	No Load Amps.	1
Full Load Torque (oz. in.)	11	Stalled Torque (oz. in.)	4.75

Our engineers, specialists in problems involving small motors, will welcome the chance to help you get the *right* motor for the job.

☆ ***Pilot Motors are available in ratings from 1/500 to 1/8 H.P.***

FASCO

F. A. SMITH MFG. CO., 401 DAVIS STREET, ROCHESTER 2, N. Y.

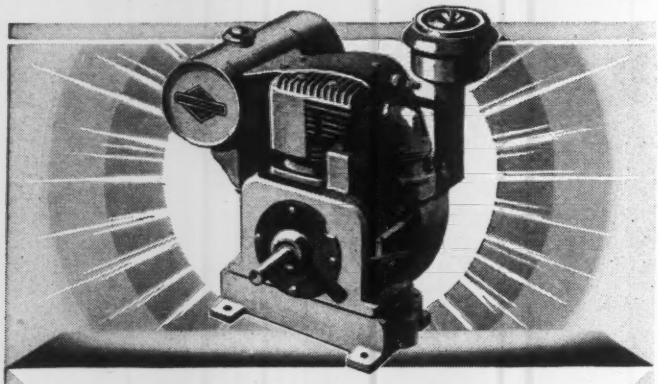
POWER WITH

BRIGGS & STRATTON

Air-Cooled Engines

YOUR ASSURANCE OF

MAXIMUM PERFORMANCE



In a brilliant record of dependable, economical operation—well above 2¼ MILLION Briggs & Stratton 4-cycle gasoline engines have *earned undisputed* recognition as "preferred power" the world over. Current models are the result of skill and experience gained during more than 26 years of *continuous production*—and constant advancements in design and precision manufacture. These distinctive Briggs & Stratton advantages are your assurance of *maximum performance*—whether you build, sell, or use gasoline-powered appliances, machinery, or industrial equipment.

BRIGGS & STRATTON CORPORATION
Milwaukee 1, Wis., U. S. A.

Air-Cooled Power

4 CYCLE
BRIGGS & STRATTON
GASOLINE ENGINES

Ill., area; L. B. Wallner, district welding engineer at Duluth, Minn., replacing I. R. Bartter who has been promoted to welding engineer at the Grand Rapids, Mich., office; and C. M. Burnett, welding engineer in the Boston area.

♦

Change of name and location has been made by Camden Stud Welding Corp. Henceforth the company will be known as Nelson Stud Welding Corp. and will be located at Toledo Ave. and East 28th St., Lorain, O.

Meetings and Expositions

Dec. 16-19—
American Institute of Chemical Engineers. Thirty-eighth annual meeting to be held at Stevens hotel, Chicago. S. L. Tyler, 50 East 41st St., New York 17, is executive secretary.

Jan. 7-9—
Society of Plastics Engineers. National meeting to be held at Rackham Educational Memorial, Detroit. In conjunction with the meeting a plastics exhibit will be held January 7 to 11 at Convention Hall. Thomas E. Orr, Plastic Engineering Inc., 8506 Lake Ave., Cleveland, is chairman of the meeting and exhibit committee.

Jan. 7-11—
Society of Automotive Engineers Inc. Annual meeting and engineering display to be held at Book-Cadillac hotel, Detroit. John A. C. Warner, 29 West 39th St., New York 18, is secretary and general manager.

Jan. 21-25—
American Institute of Electrical Engineers. Winter convention to be held at Engineering Societies Bldg., 33 West 39th St., New York. H. H. Henline, at the same address, is secretary.

Jan. 28-30—
American Society of Heating & Ventilating Engineers. Fifty-second annual meeting to be held at Hotel Commodore, New York. A. V. Hutchinson, 51 Madison Ave., New York 10, is secretary.

Feb. 4-7—
American Welding Society. National meeting to be held in conjunction with the National Metal congress and exposition to be held at Public Auditorium, Cleveland. Headquarters will be at Hotel Cleveland. M. M. Kelly, 33 West 39th St., New York, is secretary.

Feb. 4-8—
American Institute of Mining and Metallurgical Engineers. National meeting of the Iron and Steel, and Institute of Metals divisions to be held in conjunction with the National Metal congress and exposition, Public Auditorium, Cleveland. Headquarters will be at Hotel Statler. Frank T. Sisco, 29 West 39th St., New York, is assistant secretary.

Feb. 4-8—
American Society for Metals. Postponed 1945 annual convention to be held in conjunction with the National Metal congress and exposition, Public Auditorium, Cleveland. Headquarters will be at Hotel Statler. W. H. Eisenman, 7301 Euclid Ave., Cleveland 3, is secretary.

Feb. 6-8—
American Industrial Radium and X-Ray society. Annual convention to be held in conjunction with the National Metal congress and exposition, Public Auditorium, Cleveland. Headquarters will be at Hollenden hotel. Phillip D. Johnson, 25 East Washington St., Chicago, is secretary.

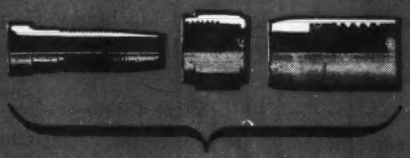
Feb. 25-March 1—
American Society for Testing Materials. Spring meeting and committee week to be held in Pittsburgh. Additional information may be obtained from headquarters of the society at 260 South Broad St., Philadelphia 2. Robert Painter is assistant to the secretary.

Feb. 25-March 2—
Twentieth Exposition of Chemical Industries to be held at Grand Central Palace, New York 17. Charles F. Roth, at the same address, is manager of the exposition.

TWO MAJOR WAR DEVELOPMENTS

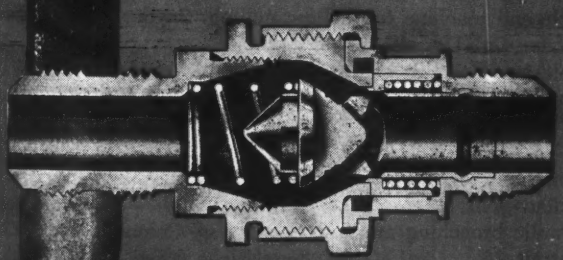
now ready for industry

1. Aeroquip Hose Lines* with detachable and reusable fittings simplify the supply problem and save valuable time, thus helping our armed forces on all fronts.



3 PIECES (each replaceable)

Assembly without special tools. No tightening or adjustment after assembly. Fittings can be removed from hose and reused over 100 times.



2. Aeroquip Self Sealing Couplings* allow disconnection of liquid carrying lines without loss of fluid and reconnection without inclusion of air.

*STANDARD EQUIPMENT ON U. S. ARMY AND NAVY COMBAT AIRCRAFT

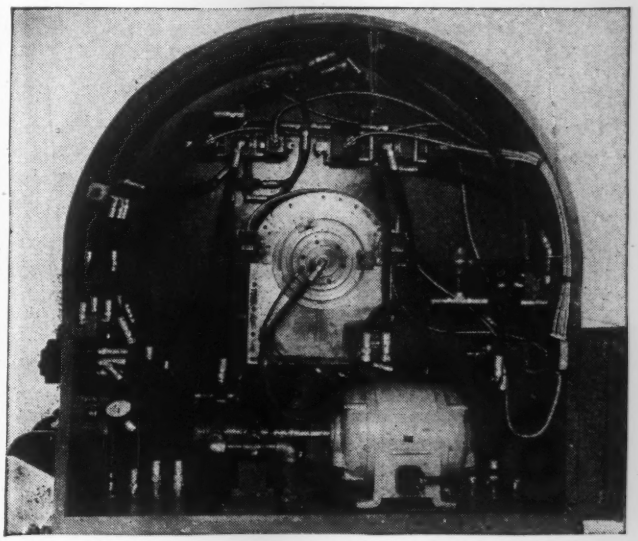
AEROQUIP CORPORATION

JACKSON, MICHIGAN, U. S. A.

MACHINE TOOL PROBLEM SOLVED

The problem of positioning hydraulic lines in the design of machine tools, and later problems of maintenance accessibility and replacement, are solved by the use of a new type of flexible Hose Line with Detachable Fittings on machine tool installations.

The simplicity of using these flexible lines in place of rigid lines not only eliminates many questions of design layout previously necessary to accommodate fixed lines, but also permits complete assembly of the machine itself, followed by the subsequent application of these flexible lines, accommodating themselves to any space available, over or around various parts.



The above view illustrates the rear of a special milling machine with three hydraulically driven milling heads. Aeroquip hose lines are handily adapted to all positions and connections where rigid tubing would have required more extensively engineered outlet and space arrangements. At the same time performance under extreme vibration has been greatly improved and failures or ruptures are practically eliminated.

Aeroquip hose lines, which are "AN" standard on U. S. Army and Navy aircraft, are suitable for all hydraulic actuation, including installations for lubrication, pressure switches and power transmission.

The detachable fitting feature simplifies maintenance, permitting quick attachment, and continued re-use of the individually interchangeable fitting parts with new hose lines "tailored to the job" on the spot by simply cutting new Hose to the desired length.

The adoption of flexible Hose Lines to Machine Tool installations is gaining rapid recognition among machine tool designers and builders.

WE CAN DO IT FOR YOU

Reflectors on lamps to light precision work on war production machines were little items—but became *mighty big* when they were no longer available. This was the position in which Vimco found themselves when they could no longer get metal reflectors for Vimcolights. *So we designed and built one of plastic.* Like many other products produced under pressure of necessity, this new reflector proved so superior that Vimco ordered them as regular equipment on their industrial lights.

This is just one example of the many instances where our engineers have cooperated with other manufacturers in originating and developing molded plastic parts. If you're planning the use of plastic parts on your product—where quality and quantity production are important factors—why not take advantage of our complete facilities?

HI-EFF

MOLDED PLASTIC
AND RUBBER PARTS

Along with our extensive production of plastics, we have specialized in molded rubber products for more than 23 years. Every phase in the designing, producing and finishing of HI-EFF molded parts—plastic and rubber—is handled in our own modern plants, each under expert supervision. Write us for further details and suggestions about molded parts to fill your requirements. Taylor Manufacturing Co., 3090 W. Meinecke Ave., Milwaukee, Wis.

TAYLOR OF MILWAUKEE

Producers of HI-EFF Molded Plastic and Rubber Products

NEW MACHINES--

And the Companies Behind Them

Air Conditioning

Self-contained dust collector, Aget Detroit Co., Ann Arbor, Mich.

Ceramic

Ceramics grinder, Divine Bros. Co., Utica 1, N. Y.

Dairy

Electric water heater, Schlueter Co., Janesville, Wis.

Milk, cream and ice cream machine, Star Metal Mfg. Co., Philadelphia.

Finishing

Variable-speed polishing lathe, Schauer Machine Co., Cincinnati 2.

Wet-belt surfacer, The Porter-Cable Machine Co., Syracuse 8, N. Y.

Food

Powder depositor, Craig Corp., New York.

Boxcar loader, Stephens-Adamson Mfg. Co., Aurora, Ill.

Air disinfection unit, American Sterilizer Co., Erie, Pa.

Automatic egg washer and dryer, Gordon Johnson Co., Kansas City 6, Mo.

Improved pea grader, Food Machinery Corp., Hoopeston, Ill.

Solid bar candy machine, J. W. Greer Co., Cambridge A-39, Mass.

Heat Treating

Excitron mercury arc converter, Allis-Chalmers Mfg. Co., Milwaukee.

Oven-type protective atmosphere furnace, W. S. Rockwell Co., New York.

Materials Handling

One-hand-control power truck, Towsley Truck Inc., Cincinnati.

Loader with 180-degree swinging boom, Jaeger Machine Co., Columbus, O.

Double-end machine for hollow milling, Snyder Tool & Engineering Co., Detroit, 7.

Double spindle milling machine, W. H. Nichols & Sons, Waltham 54, Mass.

Plate duplicator, Thomas Machine Mfg. Co., Pittsburgh 23.

High-speed forging press, National Machinery Co., Tiffin, O.

Automatic indexing machine, W. K. Millholland Machinery Co., Indianapolis, 5.

Hydraulic broaching and assembly press, Colonial Broach Co., Detroit, 13.

Horizontal boring machine, Universal Boring Machine Co., Hudson, Mass.

Planetary milling machine, Plan-O-Mill Corp., Hazel Park, Mich.

High-speed automatic die-casting machine, H. L. Harvill Mfg. Co., Vernon, Calif.

50-inch tilting hot saw, Mackintosh-Hemphill Co., Pittsburgh.

Special purpose machine for drilling, reaming and tapping thread dies, Le Maire Tool & Mfg. Co., Dearborn, Mich.

Packaging

Automatic crimp heat sealing machine, Heat Seal-It Co., Philadelphia.

Round mint patty packaging machine, Package Machinery Co., Springfield, Mass.

Welding

Engine-driven arc welder, Hobart Bros., Troy, O.

Foot-rocker action spot welder, Precision Welder & Machine Co., Cincinnati 4.

The right Characteristics the right Process

to assure maximum performance from every type of bronze part

with the various grades of

Ampco Metal

and Ampco's complete facilities

Industries and Parts \ Processes of Manufacture	Sand	Centrifugal	Extrusion	Continuous Cast	Fabrication	Forged	Ampco-clad
Acid Equipment							
Baskets	O	–	–	–	P		
Yokes and Hooks	P						
Chains (and fittings)	P	–	–	–	O	O	
Die Applications							
Forming & Drawing	O	P	O				
Expanding Punches	O	–	P				
Gear Applications							
Spur-pinion	O	P	P	–	–	O	
Worm Wheels	O	P	P	–	–	O	
Machinery, Heavy							
Screw down nuts	O	P					
Universal joint slippers	P						
Boom Sleeves	O	P					
Machine Tools							
Adjusting Nuts	O	P	O				
Lead Screw Nuts	O	P					
Bearings	O	P	–	O			
Wear Strips & Gibs	O	–	P	–	–	–	O
Leader Pin Bushings	O	P	O				
Marine Applications							
Propeller Blades	P						
Propeller Shaft Bushing	O	P	O				
Internal Combustion Engines							
Valve seat	–	–	–	–	–	P	
Bearings	P	O	–	O			
Bushings	–	P					
Miscellaneous							
Storage Tanks	O	–	–	–	P	–	O
Condensers	O	–	–	–	P	–	O
Nuts, Bolts	O	–	P				

P — Preferred O — Optional

Check your bronze parts against these recommendations by Ampco engineers.

The chart at the left is evidence that, when you specify "Ampco Metal" for bronze parts, you are really getting an *engineered material* — an alloy with special characteristics that exactly match the job requirements.

Ampco has the organization, the facilities, and the standards to assure you of *(actual) delivery — consistently* — of the *physical properties* you require, as set up in the six standard grades of Ampco Metal and modifications.

Ampco can deliver the alloy in the *shape and form* you require, because Ampco is completely equipped to fabricate the part by the *best* process for your purpose. The successful application of many metalworking processes — both orthodox and new — to aluminum bronze was pioneered by Ampco. The metal can be cast, wrought, extruded, rolled, etc., etc. — and finish-machined if you so desire — by one organization with over a quarter-century of specialized aluminum bronze experience.

Where you need exceptional resistance to wear, impact, fatigue, or corrosion, investigate Ampco Metal. Let Ampco engineers assist you in setting up specifications for better performance of *your* equipment. Write for technical bulletins.

AW-17

Reg. U. S. Pat. Off.

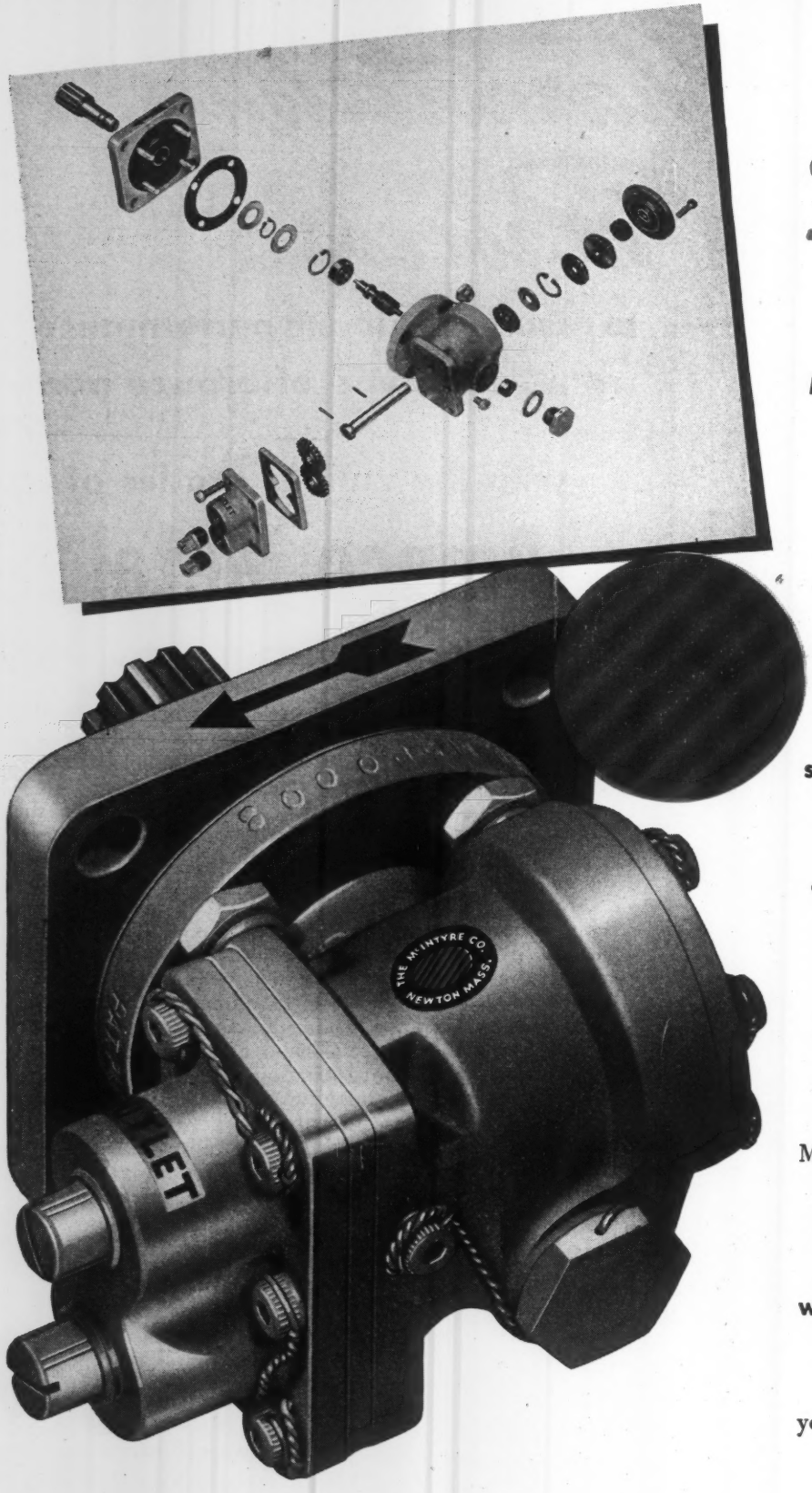
AMPCO

Ampco Metal, Inc.

Department MD-12 Milwaukee 4, Wisconsin

When considering bronze, remember that *aluminum bronze* offers these advantages:

- **— lighter than other bronzes.**
- **— stronger than other bronzes.**
- **— lower-priced than other bronzes.**
- **— has higher fatigue and impact values.**
- **— has higher compressive strength.**
- **— has higher strength at elevated and sub-zero temperatures.**
- **— contains only native metals — copper, aluminum, and iron.**
- **— is a good bearing alloy.**



This Simplified Pump

Makes Pressure Lubrication Trouble-Free

Bearings of machine tools, Diesel engines, printing presses and other high-speed machinery get *extra* protection from pressure lubrication when this McIntyre *precision* Series 400 gear-type pump force-feeds 1½ to 20 quarts of oil per hour to the "trouble" spots.

SIMPLE DESIGN. Operating up to 3000 RPM against all normal working pressures, this pump gets its trouble-free properties from the simple arrangement of easily-changed center-plate and spur gears, built-in reduction-gearing, spline-drive shaft, A.N.D. 10,000 or 10,001 mounting pad. It's easy to mount, easy to drive, easy to maintain. Also adaptable to pulley, direct-connected or other standard drives.

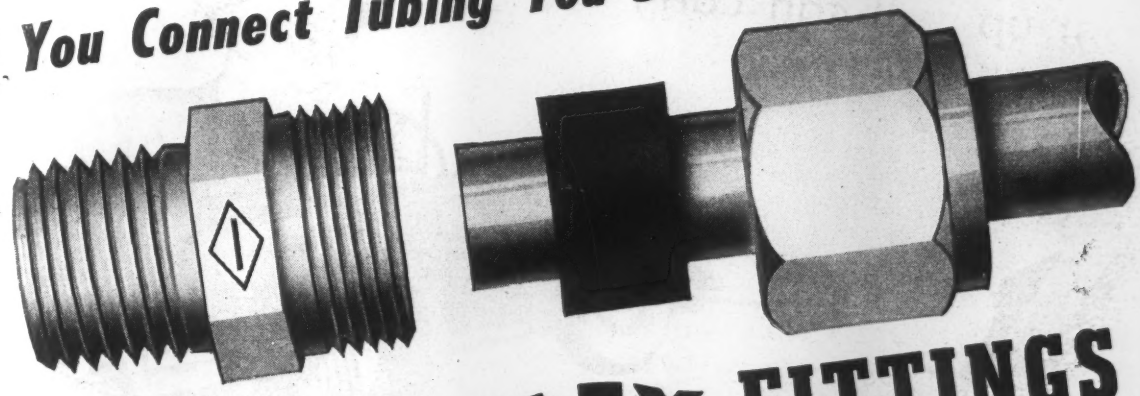
McINTYRE PRECISION. When you see the light-band trade-mark on any McIntyre Pump or Fluid Motor, remember that it symbolizes machining methods *capable of making surfaces flat to one light-band . . . of holding vital dimensions to a plus or minus tolerance of .000025"*

WRITE FOR LITERATURE. Additional data on the performance of McIntyre Pressure Lubrication Pumps is contained in Bulletin 420. Describe application when you write for your copy. The McIntyre Co., 15 Riverdale Ave., Newton 58, Mass.

THE McINTYRE CO.
(FORMERLY ZENITH ASSOCIATES)
PUMPS AND FLUID MOTORS

THE ULTIMATE IN PRECISION — *IDENTIFIED BY THE LIGHT BAND*

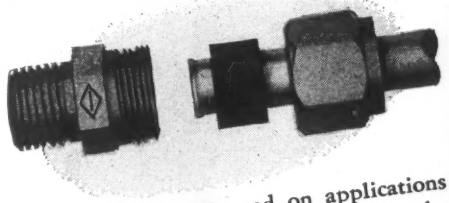
If You Connect Tubing You Should Know About . . .



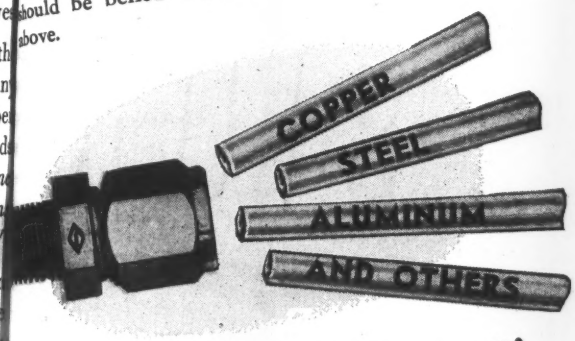
IMPERIAL FLEX FITTINGS

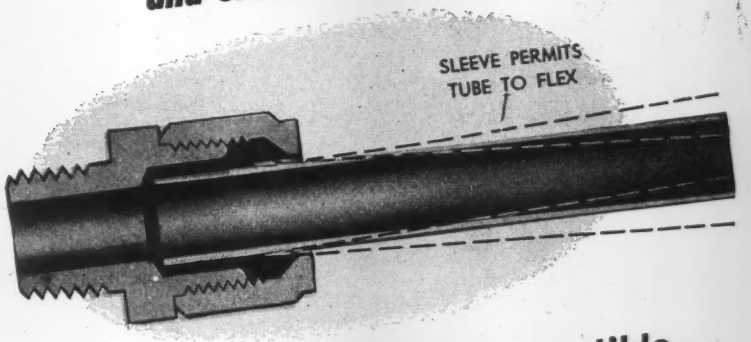
. . . the tube coupling with the vibration and shock absorbing sleeve

Easy to Install . . . All that is necessary is to slip nut and Flex sleeve over tubing. Then insert tubing into fitting body as far as it will go, and assemble. This applies to sizes ½" O.D. and smaller where low pressures are involved.



In sizes larger than ½" O.D. and on applications where higher pressures are involved, end of tube should be belled slightly, as shown in illustration above.





Makes Joints Virtually Indestructible by Vibration . . . . . . The Flex Fitting embodies a sleeve of special synthetic elastic material which permits the tubing to flex back and forth through the angle shown and at the same time assures a positive, pressure-tight seal.

It assures a safe, durable tubing installation that will withstand major vibration, minor tube movement and considerable mechanical shock without damage to either tubing or fittings. On tests where ordinary fittings failed after 73,000 cycles of vibration, Imperial Flex Fittings have withstood over 20,000,000 cycles without failure.

Flex Fittings eliminate the need for costly flexible hose lines in many instances.

Proved by extensive service in the field. Used as standard equipment on Diesel engines, oil filter connections, heavy power equipment, machinery, etc.

For All Kinds of Tubing . . . . . . Imperial Flex Fittings can be used with all types of seamed and seamless metal tubing, including copper, aluminum, thin-wall steel, Monel, stainless steel, etc.

Catalog No. 344 gives complete engineering data on Flex Fittings including types, sizes, dimensions, specifications and application information. **Write for your copy.**

Emblem of Quality

IMPERIAL

THE IMPERIAL BRASS MANUFACTURING COMPANY

513 S. Racine Ave., Chicago 7, Illinois

PIONEERS IN TUBE FITTINGS AND TUBE WORKING TOOLS

EVENING

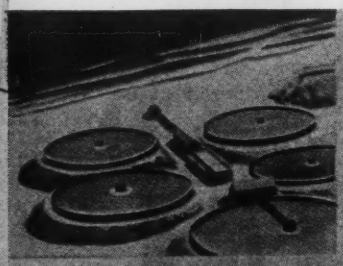
"just wrap it up . . . I can carry this light one home"

A happy surprise . . . that first experience with ultra-light *magnesium!* ☆ You may meet it in buying a bulky metal toy . . . finding it unbelievably light. Such a toy is easy to carry up and down steps . . . in and out of playroom or basement. You'll bless that lightness! And magnesium is tough and sturdy, too—equal to all the punishment five-year-olds can give it. ☆ Millions will gladly pay a little more for products freed from useless weight. ☆ Dow makes no toys. As the leading producer of magnesium metal, however, it cooperates with manufacturers in many fields who are developing a growing variety of new lightweight products for you. Keep your eyes open for them!

Ready... to make products move!

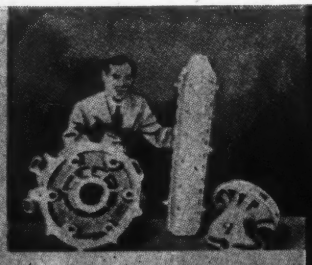
MAGNESIUM

LIGHTEST OF ALL STRUCTURAL METALS



From the limitless sea—and from inland brine wells—Dow, magnesium pioneer and leading producer, supplies magnesium for varied and widespread uses.

Throughout the nation are fabricators skilled and experienced in working magnesium—ready to supply manufacturers of modern, lightweight products.



From toys to aircraft engines, present and prospective magnesium products include diversified consumer items and many applications important to industry.

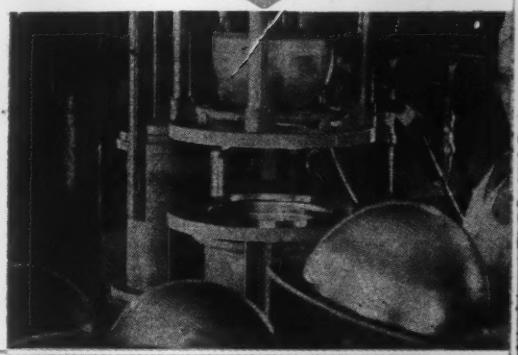
MAGNESIUM DIVISION • THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN • New York, Boston, Philadelphia, Washington, Cleveland, Detroit, Chicago, St. Louis, Houston, San Francisco, Los An

Here's how MAGNESIUM *sells—and works!*

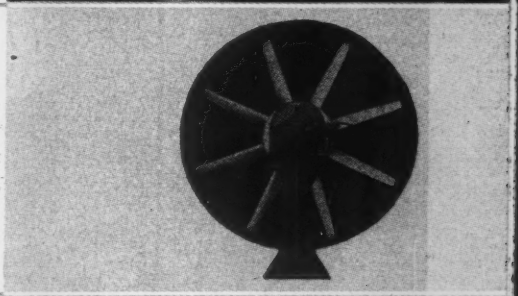
People will buy *lightness*—just like the gentleman on the opposite page! They'll even pay a little more, if necessary, to get it. Magnesium—lightest of all structural metals—gives consumer products a special appeal that makes them *sell faster* because it makes them *better.* It's true in industry, too. Alert designers, fabricators, manufacturers are thoroughly aware that many industrial products can be bettered . . . made more salable . . . with magnesium. It gives you lightness, strength, easy workability—does something for industrial products that no other metal can do. Great strides have been made in magnesium application; greater ones are in the making.

MAGNESIUM DIVISION • THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

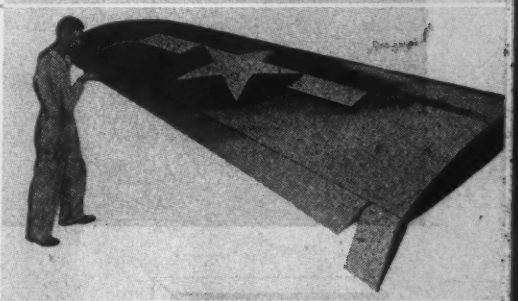
New York • Boston • Philadelphia • Washington • Cleveland • Detroit • Chicago • St. Louis • Houston • San Francisco
Los Angeles • Seattle



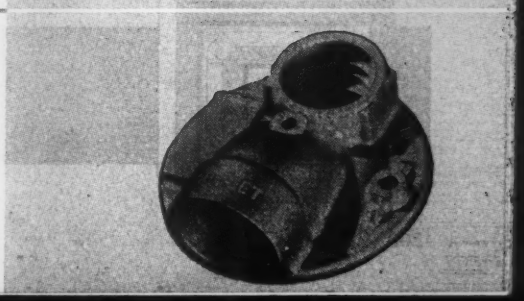
DEEP DRAWN PARTS of many kinds are produced of magnesium in a single cost-saving operation. Cylindrical cups, for example, are commonly drawn to a depth of 1½ times their diameter in a single draw by this hot forming method. Similar results with steel would require drawing, annealing, and redrawing several times.



CUTTING INERTIA is a cost-saving job magnesium is doing in successful applications in numerous fields. Important in various types of equipment subject to frequent starts and stops, containing high-speed rotating members, and performing reciprocating movements at high speeds—this reduction of inertia cuts wear and tear, maintenance, replacement.



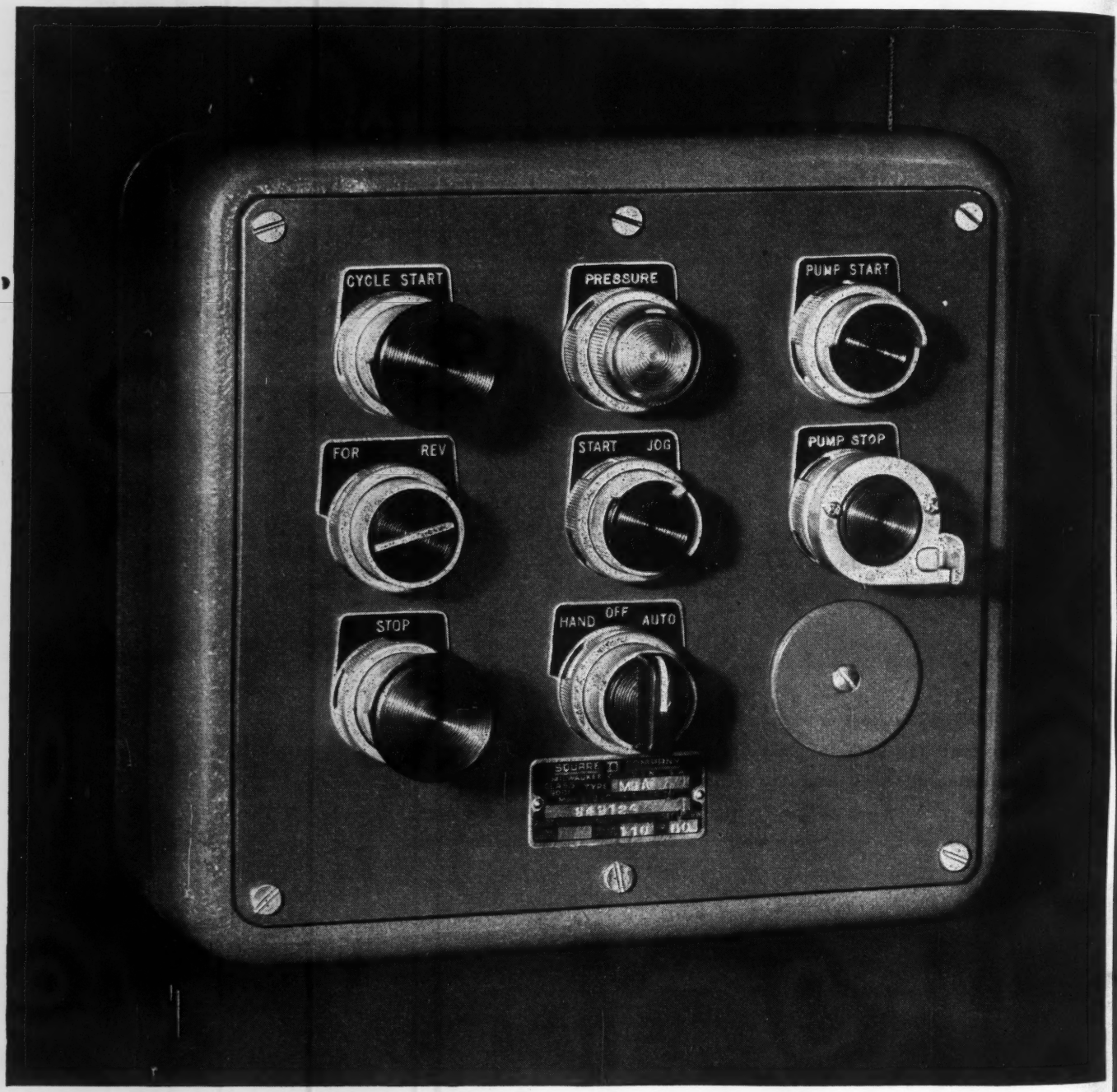
IN AIRCRAFT, one signal achievement among the many which magnesium has scored is the use of thicker sheet—without weight penalty—permitting use of flush rivets, machine countersunk, instead of dimpled rivets, on aileron skins. This construction avoids "oil-canning" and gives a completely smooth surface.



DIE CASTINGS of magnesium are gaining a growing place in many fields. Leading die casters are turning out parts and finished products of magnesium with accurate dimensions, a minimum of machining, good surface finish, low cost—in addition to the fundamental magnesium advantages of lightness and high strength-weight ratio.

(Left) Reprint of a Dow advertisement seen by millions of readers in national magazines.

THESE OILTIGHT PUSH
COMBINE TO MEET



SQUARE D COMPANY

DETROIT • MILWAUKEE • LOS ANGELES

BUTTON UNITS *Any* NEED

DESIGNED SPECIFICALLY FOR MACHINE TOOL SERVICE, THIS *COMPLETE* LINE AFFORDS MAXIMUM FLEXIBILITY WITH MINIMUM STOCK

●Check these features in terms of your own requirements. See if these units don't answer *your* push-button problems—completely.

★ Proven oil-tight and coolant-tight by severe tests involving millions of operations.

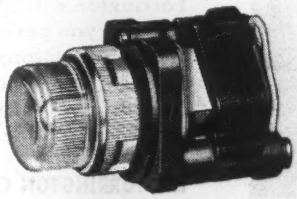
★ Much more compact, they require substantially less panel and back-of-panel space than previous designs. And they can be mounted in any position.

★ Flexibility to the Nth degree. A virtually unlimited number of combinations can be obtained from the standard units shown at the right.

★ Interchangeable with older types LO, PO and MO units, when desired.

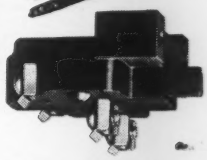
Ask your Square D Field Engineer for detailed information on this most complete and flexible of all pushbutton lines. Or write Industrial Controller Division, Square D Company, 4040 N. Richards Street, Milwaukee 12, Wisconsin, for Bulletin No. 202.

Coming! A new pilot light that has everything. Plenty of illumination and wide-angle visibility. Vastly reduced filament burn-outs. No loosening of lamps under vibration. Styled to match buttons.

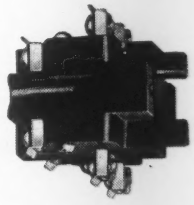


★ ★ ★ ★

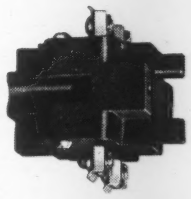
ANY *Block*



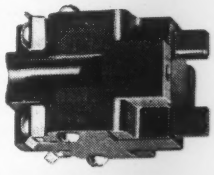
Single Pole N.O. and N.C. Contacts



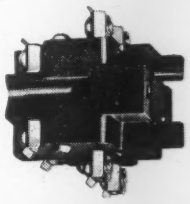
Duplex N.O. and N.C. Contacts



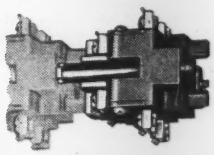
Duplex N.C. Contacts



Duplex N.O. Contacts

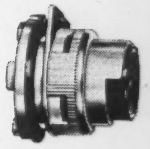


Duplex N.O. and N.C. Contacts with one N.O. circuit closing ahead of the other. For 2-speed or sequence operations.

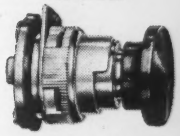


Duplex N.O. and N.C. Contacts with stems extended for tandem operation with another block.

WITH ANY *Operator*



Momentary Contact Guarded Button Red or Black



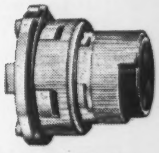
Momentary Contact Mushroom Button Red or Black

Lockout Attachment for Momentary Contact Buttons, with provisions for padlocking

Maintained Contact Attachment used with two Operators and one Contact Block

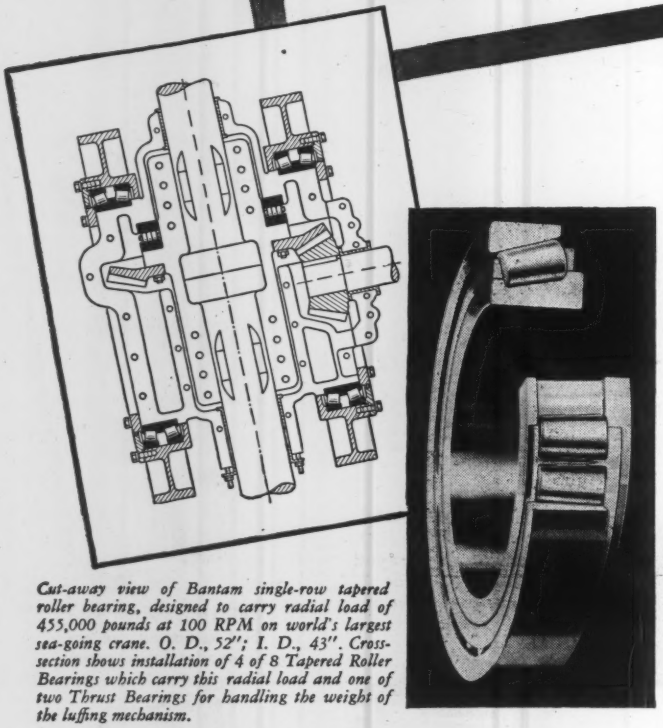
Selector Switch 2 Positions or 3 Positions with 4 different Operating Cams

Selector Switch with Slot to discourage unauthorized operation



Selector Pushbutton Combining Selector Switch and Pushbutton functions in a single unit

HELPING LIFT THE LOAD
ON WORLD'S LARGEST FLOATING CRANE



Cut-away view of Bantam single-row tapered roller bearing, designed to carry radial load of 455,000 pounds at 100 RPM on world's largest sea-going crane. O. D., 52"; I. D., 43". Cross-section shows installation of 4 of 8 Tapered Roller Bearings which carry this radial load and one of two Thrust Bearings for handling the weight of the luffing mechanism.

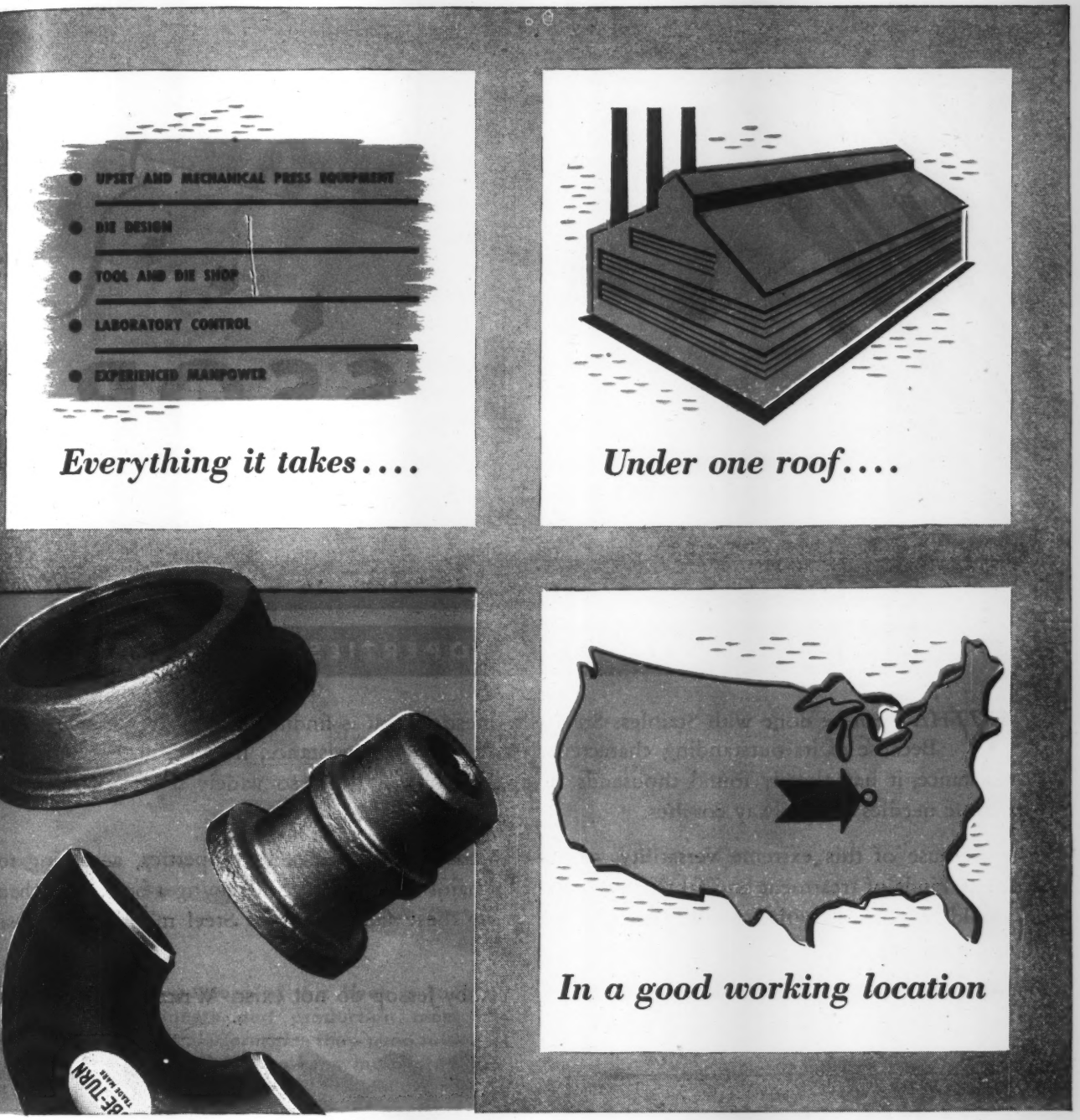
When you start lifting 125 tons or more of dead weight out of the ocean, you can't take any chances with the tremendous radial and thrust loads involved. That's why, when Anthony M. Meyerstein, Inc., was asked to build the world's largest sea-going crane (*shown above*), they turned to Torrington to engineer and build the bearings which would carry these loads. Result: eight specially-designed Torrington Bantam Tapered Roller Bearings handle the radial load for the luffing drive with tons to spare; two specially-designed Torrington Bantam Thrust Bearings carry the weight of the luffing mechanism with the same sure, safe ease.

Designing such unusual jobs for heavy industry is all in the day's work for Torrington engineers. No matter how big or complex your load or friction problem, Torrington will solve it for you... solve it with bearings that give you peak performance, ease of lubrication and maintenance, long years of outstanding, trouble-free service. Save yourself time, headaches and money by consulting Torrington whenever you have bearing problems, routine or unusual.

THE TORRINGTON COMPANY · BANTAM BEARINGS DIVISION
SOUTH BEND 21, INDIANA

TORRINGTON BEARINGS

STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL



BETTER SERVICE *in Better Forgings*

WHEN improving present products or designing the new, think of forged steel parts. For a *dependable* source of these, think of Tube Turns. This ideally located organization maintains everything necessary for the mass-production of better forgings. Every operation is centered under one roof, one responsibility.

Tube Turns' plant includes modern mechanical and upset press equipment up to 9 inch capacity, an unexcelled die design department, a major tool and die shop, complete laboratory facilities, complete heat treating facilities, rough machining facilities, and men whose experience (founded upon the exacting requirements involved in the forging of *Tube-Turn* seamless welding fittings) has fulfilled many forging assignments with efficiency and dispatch.

Please feel free to call upon Tube Turns' engineers for any kind of consultation about forged steel which may be helpful to you. No obligation, of course. TUBE TURNS (Inc.), Louisville 1, Ky.

TUBE TURNS *Forgings for Industry*

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Stainless Steels

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WHAT can be done with Stainless Steel is a question that is finding a new answer every day. Because of its outstanding characteristics of corrosion resistance, heat resistance, and acid resistance, it has already found thousands of applications in fields so widely separated as hypodermic needles and railway coaches.

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Higher grade Stainless Steels than those produced by Jessop do not exist. Write for the catalog.

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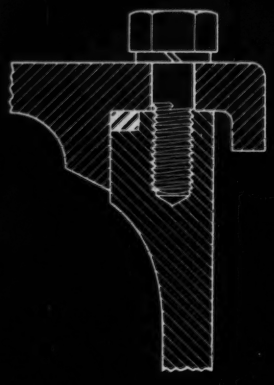
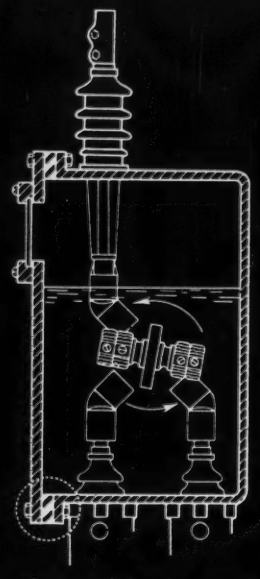
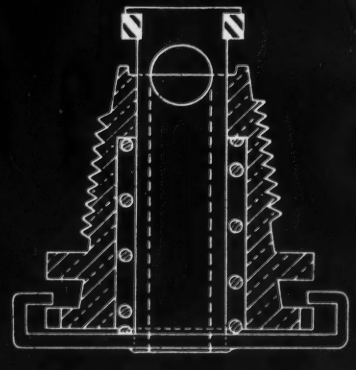


Truly compressible cork-and-synthetic-rubber gasket permits rigid metal-to-metal assembly, seals light oil.



Resilient, sulphur-free, cork-and-synthetic-rubber gasket seals oil-filled switch cover; compresses without sideflow.



Synthetic rubber washer seals drain cock under light spring pressure; assembled over flange; withstands oils, aromatic fuels

Solve difficult gasket problems in less time, at lower cost

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You'll get faster, more economical solutions to your low and medium temperature gasketing problems at Armstrong. Here you may choose from more than 50 scientifically formulated, resilient sealing materials. Each one is designed to meet a specific class of problems exactly. Thus, in most cases, a stock material from Armstrong will handle your job . . . without delay or costly, special compounding.

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A new technique to determine stress limits for high-temperature alloys

$\sigma = \frac{Mc}{I}$

means improved design for high-speed machinery

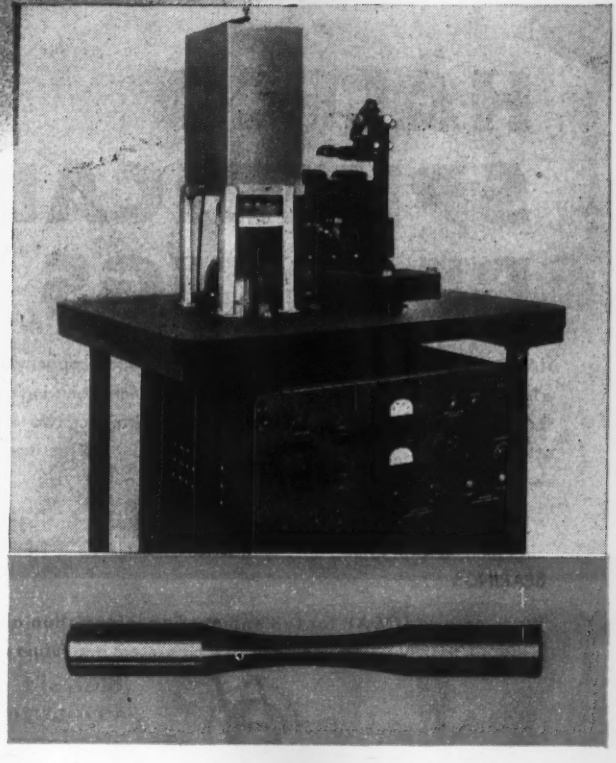
This formula for maximum section stress in a beam has gained new meaning for designers of steam turbines, gas turbines and jet propulsion engines. Westinghouse high-temperature fatigue equipment will now stress metals at 7200 cycles per minute at temperatures up to 1500° F.

Basically, the equipment is a fixed-cantilever, constant-deflection type fatigue testing machine, designed for the application of alternating bending to a standard specimen. It offers important advantages over previously-used equipment for high-temperature fatigue testing:

1. The specimen is easily prepared (see illustration), contrasted with the former complicated, highly-machined specimens required by other types of fatigue equipment.
2. An electronic control circuit maintains constant amplitude.

Operation is simple. The amplitude is read directly through a calibrated microscope mounted on the equipment. Heat is supplied by a simple bell-type electric furnace, the temperature of which is thermostatically controlled. Maintenance is negligible. No bearings or other lubrication points to service.

Your nearest Westinghouse office can give you all the facts on this timesaving, accurate achievement in high-temperature fatigue testing. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-08134



High-temperature fatigue equipment, shows bell-type furnace (top) and control panel (bottom). Inset shows easily-prepared specimen ready for test.

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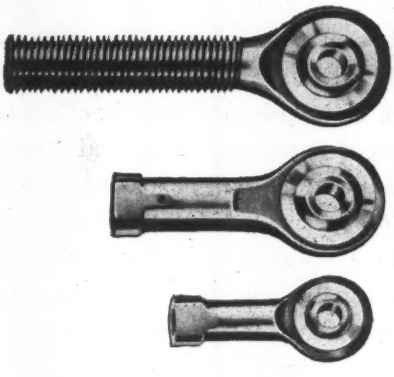
Write or wire TODAY for full engineering information about HALFCO SPHERICAL BEARINGS, and their present and future uses!



A few of the many rod ends available fitted with HALFCO SPHERICAL BEARINGS.

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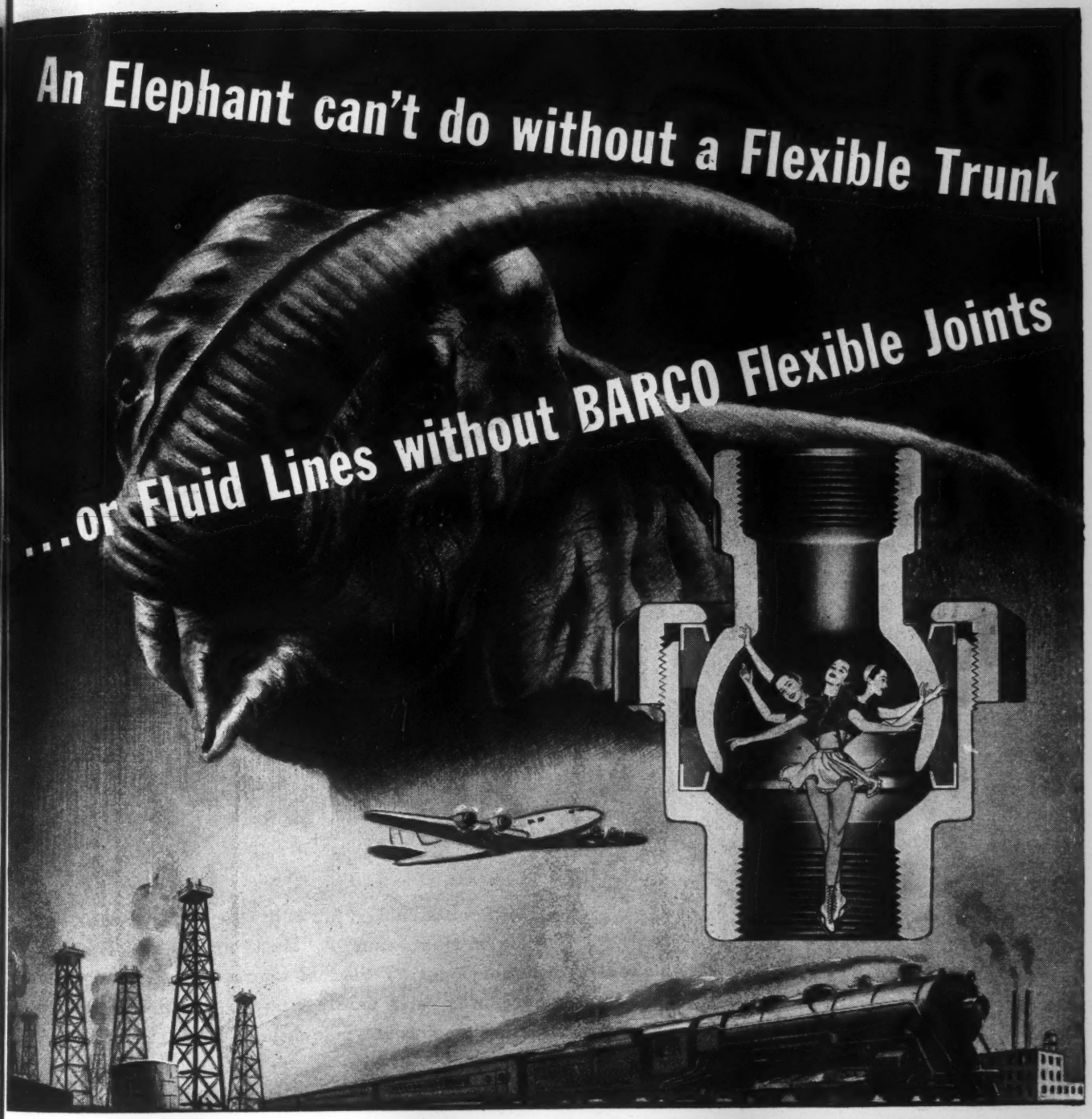
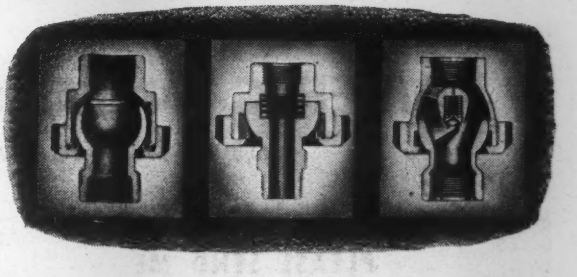
...or Fluid Lines without BARCO Flexible Joints



Nature provides flexibility in every living, moving thing. Because there is always movement—vibration, expansion, contraction—in any fluid-conveying system, Barco Flexible Joints are needed to provide responsive, compensating movement through every angle. For over 30 years they have been accepted as the standard for such protection against strain and shock. For complete engineering information, write to Barco Manufacturing Co., Not Inc., 1806 Winnemac Ave., Chicago 40, Illinois.



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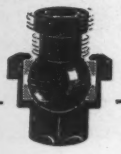
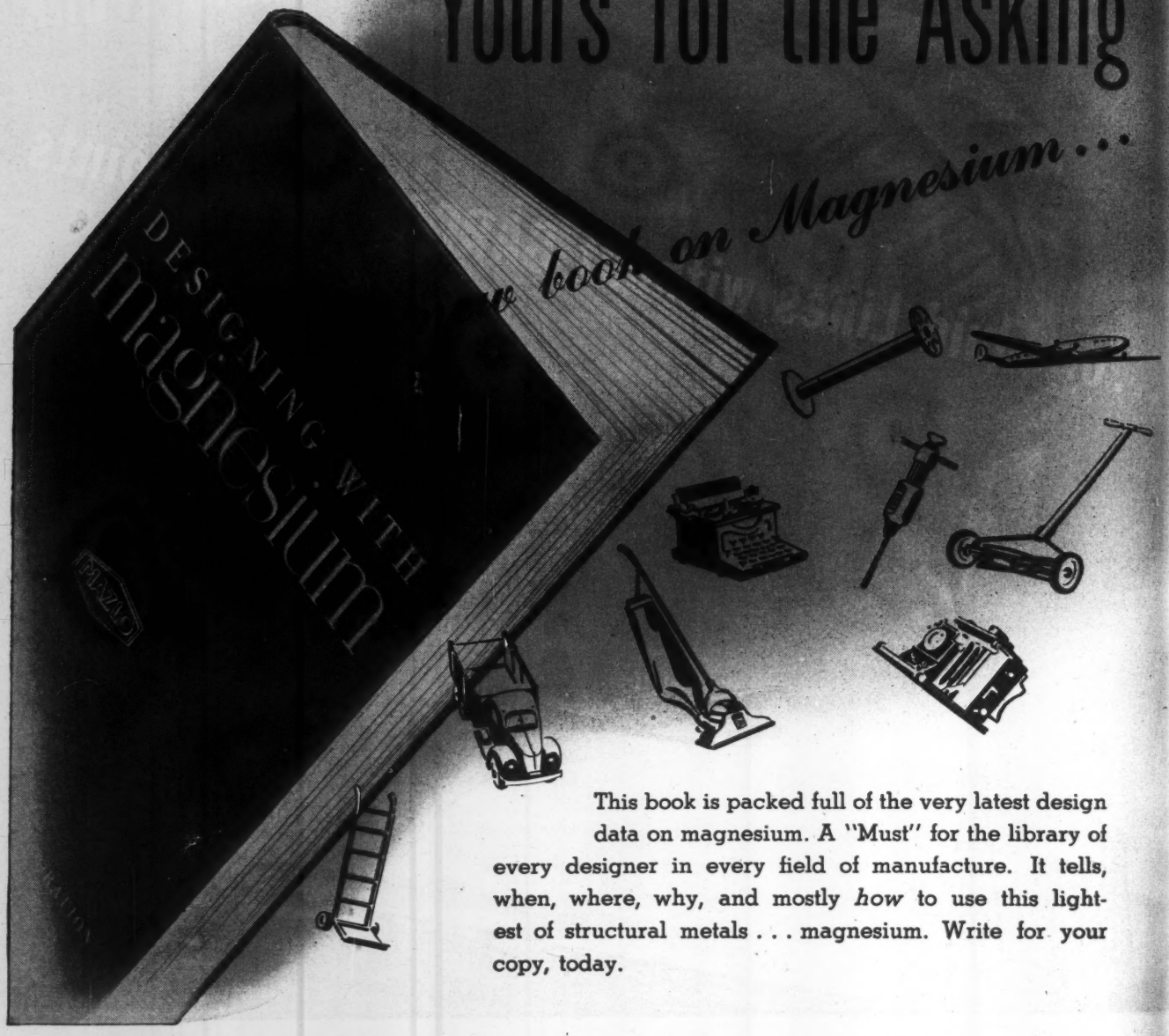


Yours for the Asking

...a new look on Magnesium...



This book is packed full of the very latest design data on magnesium. A "Must" for the library of every designer in every field of manufacture. It tells, when, where, why, and mostly *how* to use this lightest of structural metals . . . magnesium. Write for your copy, today.

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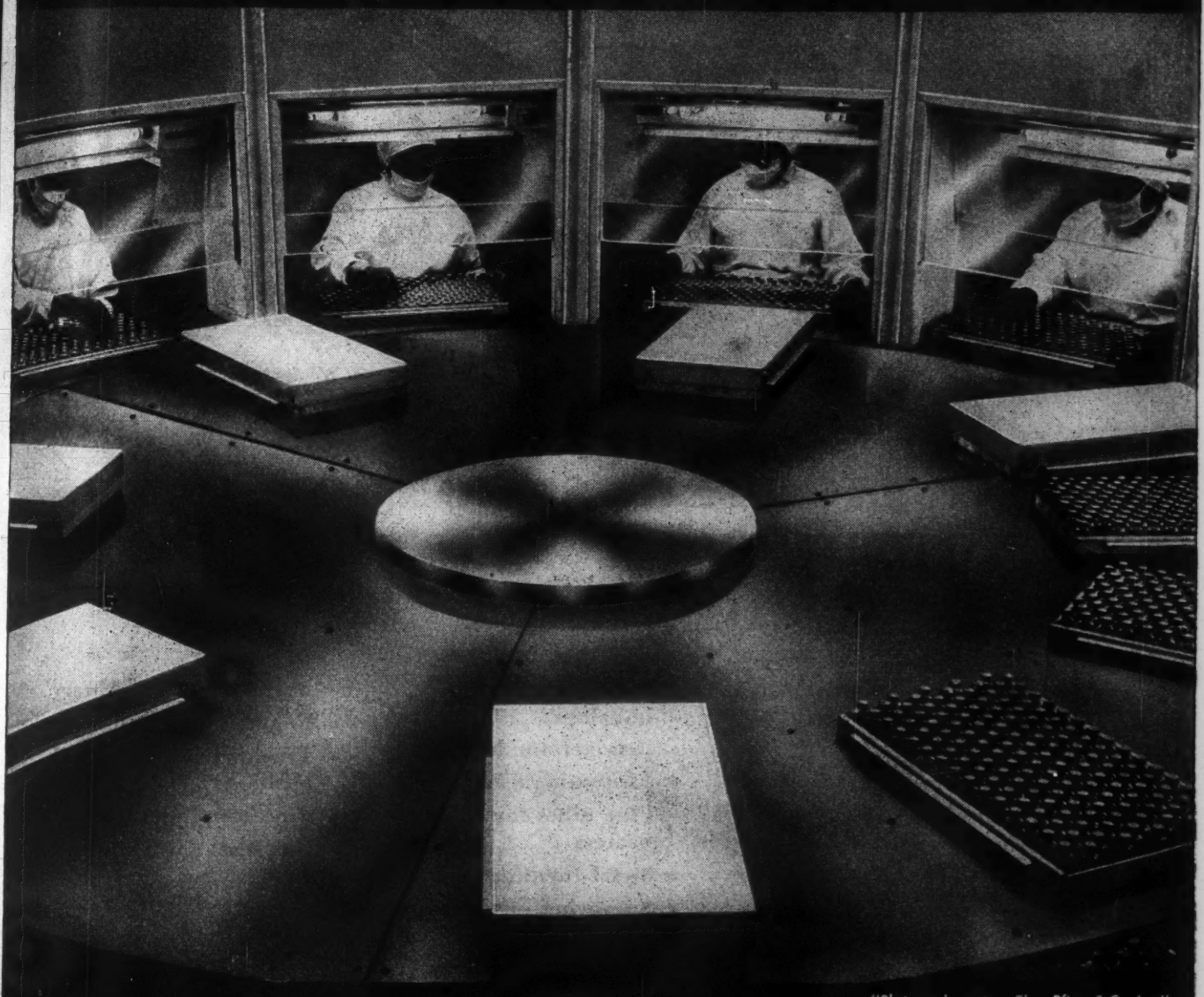

"Photograph courtesy Chas. Pfizer & Co., Inc."

Packaging the miracle drug... penicillin...calls for completely sterile conditions. Here the table must be the very acme of aseptic cleanliness... easy to clean and keep clean. Hence, it's chromium-Nickel stainless steel.

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International Nickel are miners, smelters and refiners of Nickel, an important ingredient of the stainless steels, but do not produce stainless steels. If interested, please communicate with your established sources of supply for stainless steels.

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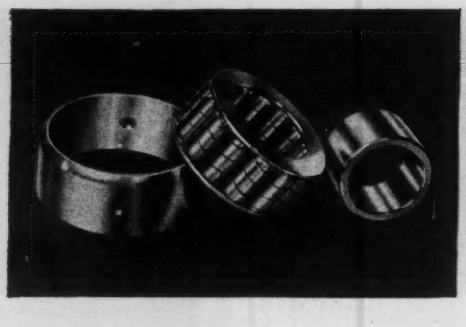

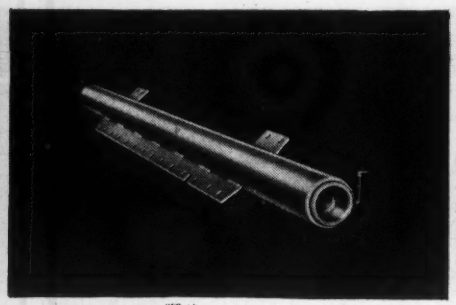

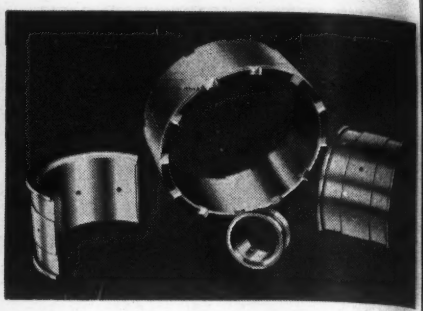

War-born Ideas for

MAKE LIGHTER, STRONGER PARTS AT LOWER COST WITH B&W TUBES

A Few of the Many Peacetime Uses for B&W Mechanical Tubing...

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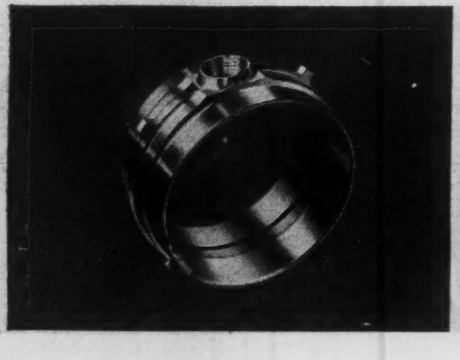
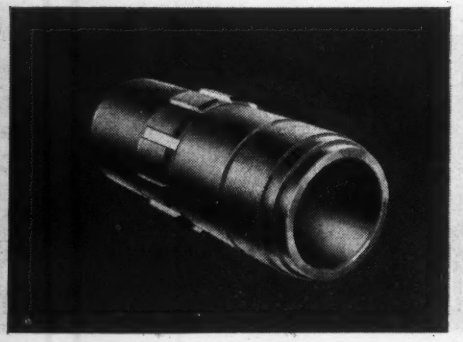
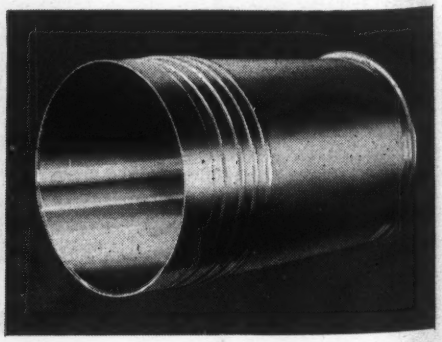
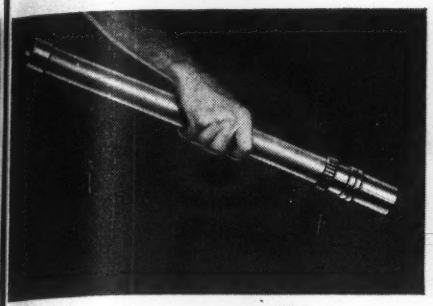
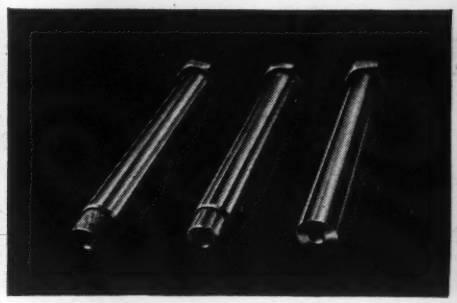
- Refrigerator tubing
- Fire extinguishers
- Flue tubes for water heaters
- Metal furniture
- Surveying instruments
- Agricultural machinery
- Engine cylinder liners
- Tractor parts, pins and bushings
- Pipe couplings and fittings
- Bus seats and hand rails
- Air compressors

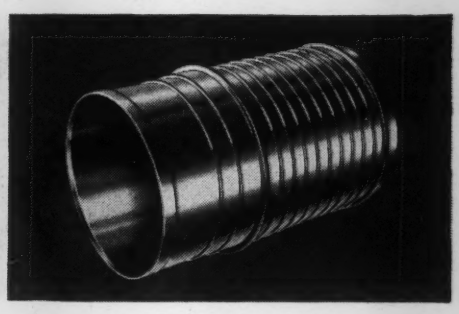












Peacetime Products:

HOLLOW structural assemblies or precision working parts made from B&W Mechanical Tubing give *lightweight* construction with *heavyweight* ruggedness and dependability. Warplane design demonstrated this fact and peacetime aircraft production will reap the benefit. In hundreds of other post war products, too, where lightweight ruggedness is important, B&W seamless and welded mechanical tubing offers practical design and production short-cuts that are worth looking into.

Take a moment to study the few parts shown here. All were made of easily-worked, dimensionally-accurate B&W Mechanical Tubing. Most of them were formerly made from costly-to-handle bar stock or forgings. Check into the possibilities of B&W tubing for speeding production on *your* peacetime products—and making important savings in time, costs and materials.

From its modern specialty tube mills, B&W can supply mechanical tubing—either seamless or welded — of the proper analysis, size, gauge, temper and finish for making practically any hollow machined or fabricated part. Let us know what you plan to make and we will gladly tell you how B&W Tubing can save you time and money.

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THE BABCOCK & WILCOX TUBE COMPANY

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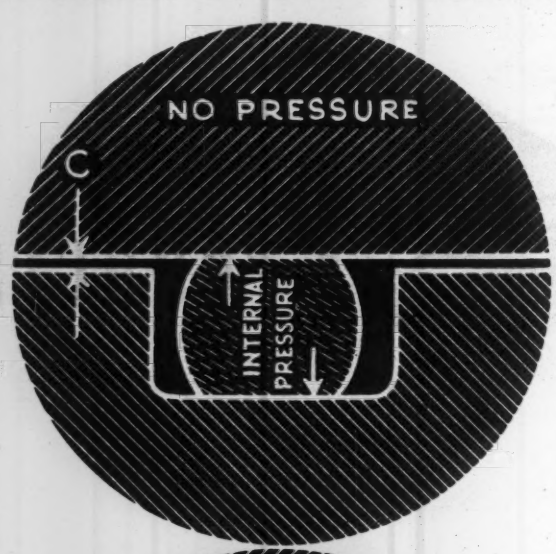
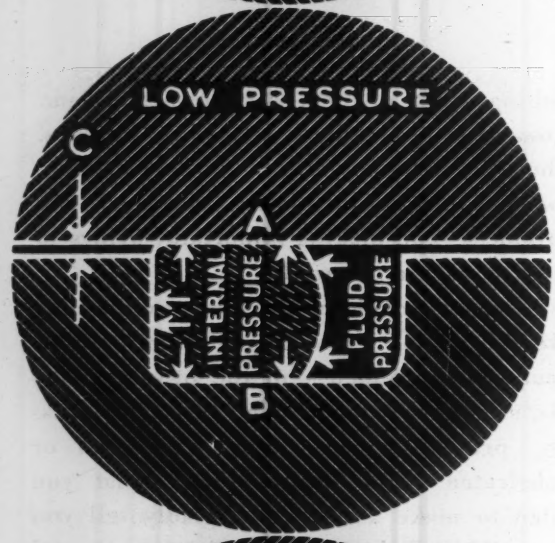
TA-1345 T

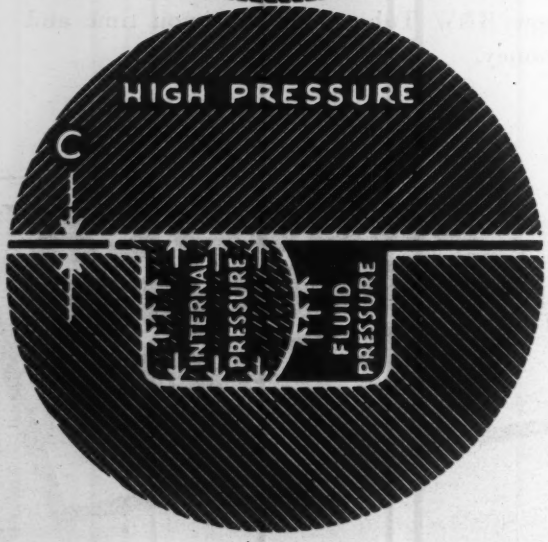
LINEAR O-Ring Packings . . .

Simple, Economical, Effective

"The Modern Hydraulic Seal"







O-Ring packings may be described simply as elastic rings with normally circular cross-sections. On account of their extreme simplicity, O-Rings require no adjustments and are readily replaceable. They occupy small space and seal in both directions. Made of a highly resilient synthetic rubber compound, Linear O-Ring packings seal effectively at low and high pressures. Their frictional drag is low. The action of these packings is shown in the accompanying diagrams.

◀ **At zero pressure,** seal is maintained by pressure of O-Ring on sealed surfaces resulting from cross-sectional squeeze. No extrusion through clearance "C."

◀ **Low pressure (1 to 1000 p. s. i.)** moves O-Ring to left side of groove, causing radial expansion of packing against sealed surfaces "A" and "B," proportional to pressure. Excessive clearance will permit extrusion at "C."

◀ **High pressure (over 1000 p. s. i.)** intensifies sealing action, also increases extrusion tendency at "C." Extrusion may be eliminated by reducing "C," or by the use of non-extrusion rings. Note: Covered by Christensen United States patent No. 2,180,795.

Consult Linear engineers for the application of Linear O-Rings to your packing problems. Ask for sample rings.

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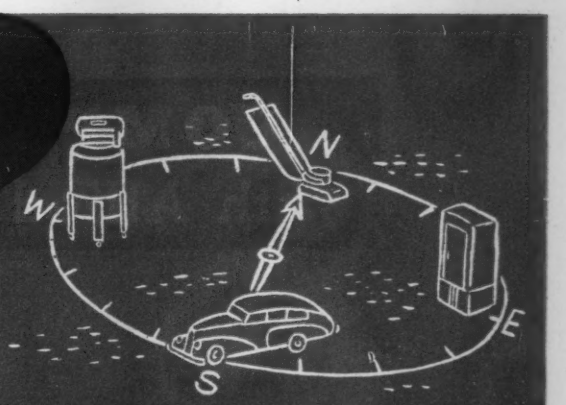
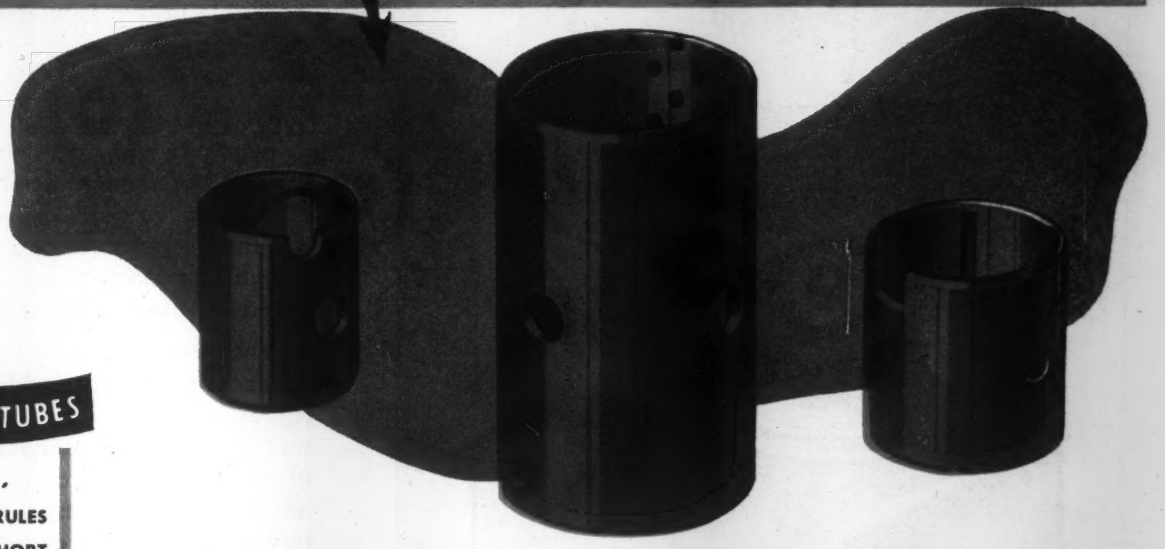


Specify

FORMETAL

"superformed" BUSHINGS and BEARINGS



also SPACER TUBES

and . . .

SLEEVES . . . FERRULES . . . TUBES IN SHORT LENGTHS OF ANY METAL OR ALLOY, CAN BE FURNISHED TO SPECIFICATION.

Bushings and bearings are vital factors in the performance of your product. FORMETAL "Superformed" Bushings and Bearings—rolled and formed from materials of controlled grain structure—provide extra quality at *no extra* cost.

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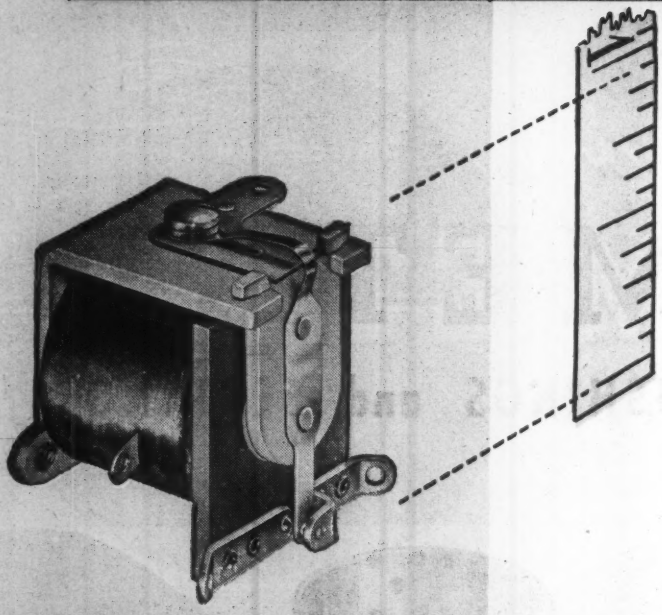
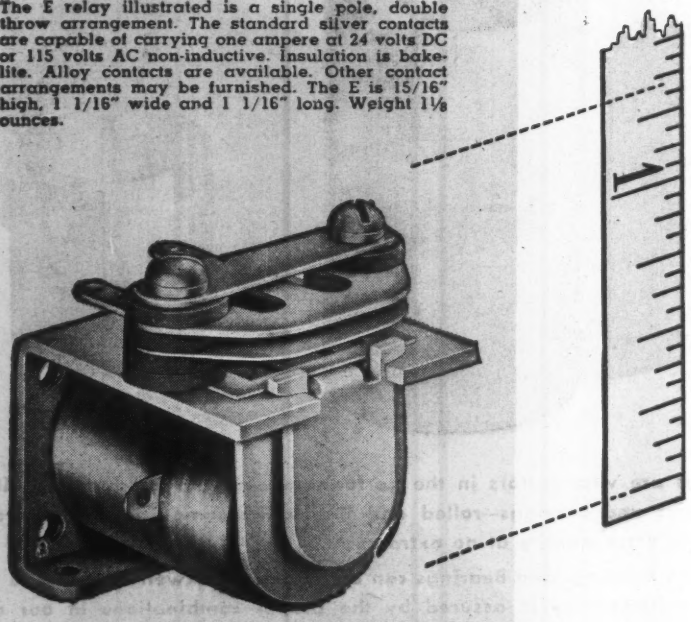
COMPACT CONTROLS
with Allied's "E" and "F" Relays



The E relay illustrated is a single pole, double throw arrangement. The standard silver contacts are capable of carrying one ampere at 24 volts DC or 115 volts AC non-inductive. Insulation is bakelite. Alloy contacts are available. Other contact arrangements may be furnished. The E is 15/16" high, 1 1/16" wide and 1 1/16" long. Weight 1⅛ ounces.



The F relay shown is a single pole, single throw normally open combination. The standard contacts carry three amperes at 24 volts DC or 115 volts AC non-inductive. Bakelite insulation is used. May be supplied on other contact combinations. Silver is standard contact material, alloy contacts can be substituted. The F is 1 11/32" high, 1 3/16" wide and 1 3/32" long. Weight is 1⅞ ounces.

DESIGNED for electronic controls in which space limitation is a critical factor, the E relay is small enough to fit into an area of approximately one cubic inch. Light too, it weighs about one ounce. The F relay, although available in two pole, double throw, is only slightly larger and weighs less than two ounces.

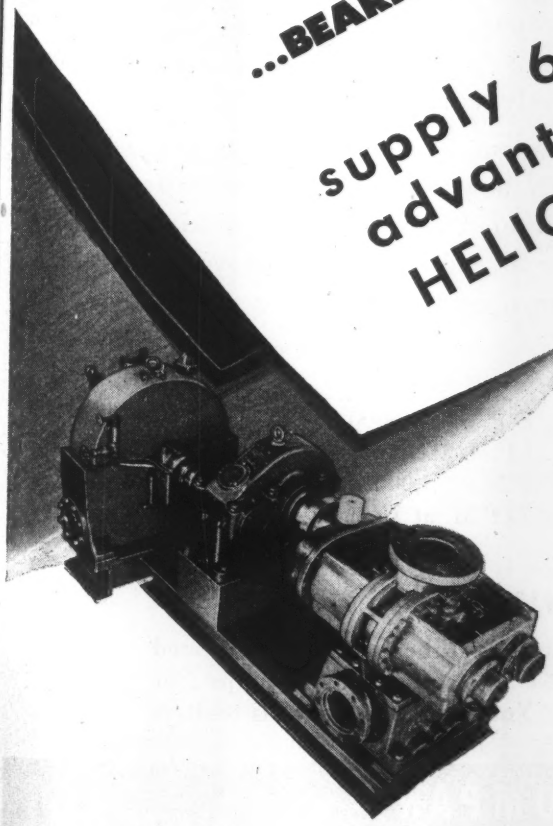
Used in your electronic assembly these relays will save you space and weight. Moreover you will be assured of positive and quiet operation, for into these relays go the same careful design and manufacturing precision found in Allied's larger relays.

Whatever your relay applications, check with Allied. In addition to sensitive, telephone, power, differential and other types of relays Allied manufactures solenoids and electro-magnetic devices. A number of strategically located plants are available to supply your immediate requirements. Allied's quality standard is in keeping with your post war products . . . write today for more information.

ALLIED CONTROL COMPANY, INC.

GENERAL OFFICES: 2 East End Ave. (at 79th St.) New York 21, N. Y. *Factories:* New York City (2 East End Ave.) — Plantsville, Conn. Chicago — 4321 N. Knox Avenue, Chicago 41, Illinois. *In California:* Allied Control Co. of California, Inc. 1633 South Hope St., Los Angeles 15, Calif.

...BEARINGS: HYATT supply 6 distinct advantages to HELIQUAD PUMPS



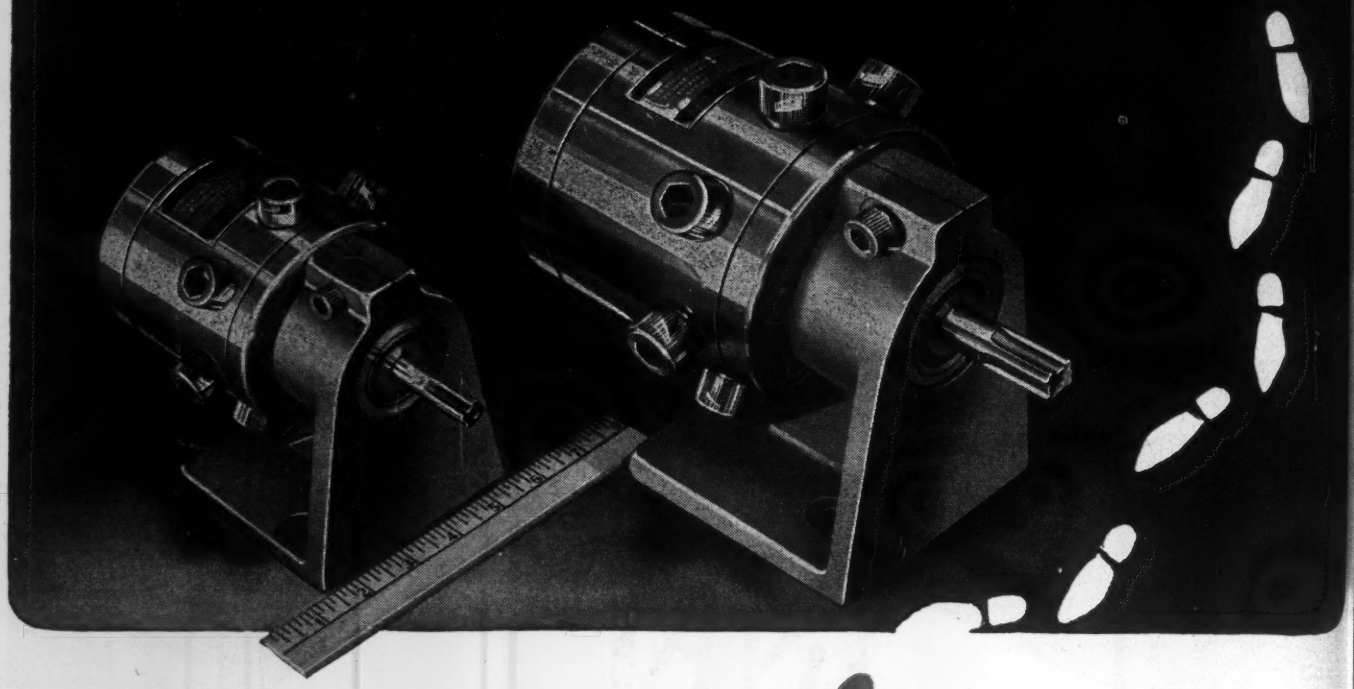
MORE THAN 20 YEARS AGO Hyatt Roller Bearings were first used in Kinney Manufacturing Company's Heliquad Gear Pump. These bearings provided six distinct advantages which have greatly helped to make this pump famous for performance:

1. **Almost total elimination of wear at bearing positions.**
2. **Packings stay concentric, wear evenly, require infrequent adjustment or renewal.**
3. **Main gears maintain correct operating relationship, last longer.**
4. **Timing gears continue to roll on their pitch lines, do not wear.**
5. **Simple external bearing mounting design is possible (due to Hyatts requiring little lubrication).**
6. **Pump starts easily, runs freely.**

Hyatt engineers will gladly consult with you on any present or future bearing problem you may have.

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION
Harrison, New Jersey • Chicago • Detroit • Pittsburgh • Oakland, California

HERE IS OUR "Better Mouse Trap"



SECO

FLUID POWER PUMPS MAKE POSSIBLE HIGHER WORKING PRESSURES WITH SMALLER, MORE COMPACT HYDRAULIC SYSTEMS

We've put the pressure *inside the pistons* in *Seco* hydraulic pumps—with the result that they generate pressures up to 10,000 P.S.I. *without loss of mechanical efficiency.* And even at their highest rated capacities they are strikingly long lived and rarely require any servicing.

Precision made from hardened tool steel. Pistons are *honed* to fit their assembly. Simple construction . . . Hydraulically operated valves . . . No packing . . . Entire piston and sleeve assembly can be removed and replaced while pump is in operation.

MODELS

20 LAL—1¼ G.P.M. at 3,000 P.S.I.	1750 R.P.M.
20 LAH—½ G.P.M. at 10,000 P.S.I.	1750 R.P.M.
80 LAL—5 G.P.M. at 3,000 P.S.I.	1750 R.P.M.
80 LAH—1¾ G.P.M. at 10,000 P.S.I.	1750 R.P.M.

INQUIRIES ARE INVITED

Manufacturers using hydraulic power pumps in quantity will be especially interested in the ruggedness and high performance data of these Seco units. Single pumps (for the replacement of outmoded units) also available. Your correspondence is invited.

SIMPLEX ENGINEERING COMPANY

MANUFACTURERS OF THE **SECO** HYDRAULIC CLOSER NOW ALMOST UNIVERSALLY USED ON FILTER PRESSES OF ALL MAKES

NEWARK ROAD,
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OXYACETYLENE WELDING

produces better tubing . . . at speeds up to 200 feet per minute

TAKING full advantage of the flexibility of oxyacetylene welding, today's manufacturers have made the production of tubing a continuous, uninterrupted, high-speed process.

Made from flat strip, formed and high-speed welded with improved methods at speeds up to 200 feet per minute, this tubing is perfectly straight, with absolute uniform wall thicknesses . . . two characteristics that make it ideal for parts subject to torque stress at high speeds and under heavy loads.

This is only one example of the broad product design and construction possibilities made feasible by welding. An almost unlimited variety of products can be produced more economically . . . faster . . . with greater strength, lightness and durability by these modern, inexpensive welding methods.

Air Reduction's nationwide Applied Engineering Department and its research facilities are at your disposal to supply the "know how" information on any design problem involving the use of the oxyacetylene flame or the electric arc. Call your nearby Airco office today or write to Air Reduction, General Offices: 60 East 42nd Street, New York 17, N. Y. In Texas: Magnolia Airco Gas Products Company, General Offices: Houston 1, Texas. Represented Internationally by Airco Export Corporation.

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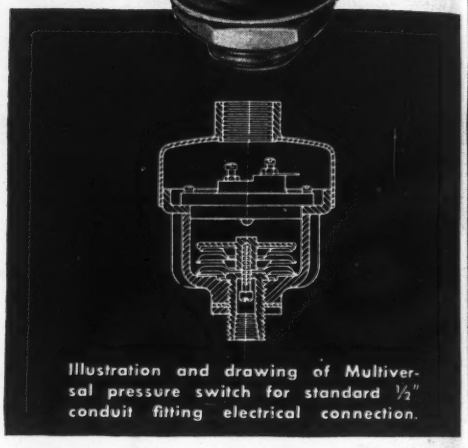

Illustration and drawing of Multiversal pressure switch for standard ½" conduit fitting electrical connection.

The MULTIVERSAL Pressure Switch

with the adjustable differential feature

Right—Multiversal pressure switch with Amphenol electrical connection.

Left—Multiversal pressure switch illustrated above is shown equipped with capillary tube and bulb, supplied in any length or style of bulb.

HERE is a wartime development by Cook engineers that is ideally suited to all industry where pressures and temperatures must be detected and controlled. The Multiversal pressure switch is fast becoming the standard control component to many manufacturers of hydraulic, gas, steam and air actuated equipment, or in processing where these factors are present and must be controlled. This switch may be used to control pressures from 2 to 30 P.S.I. and temperatures from 70° to 200° F. It also has a differential adjustment feature permitting adjustment of the "off" and "on" position within the operating range.

Pressure connection is ⅛" pipe. Electrical capacity is from 1 to 10 amperes at 120 volts A.C., depending on differential adjustment. Electrical connection can be either Amphenol or standard ½" conduit fitting. Overall size of the switch is 2¾" diameter, 2⅞" high, and weight is approximately 9 oz. This switch may also be supplied to operate on higher pressures or temperatures upon application.

This is only one of a line of Cook standard and special pressure switches that may be adapted to your control problem. Cook engineers will be pleased to recommend the proper switch for your requirement, or upon application, design a switch to meet your particular need.

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Since 1897

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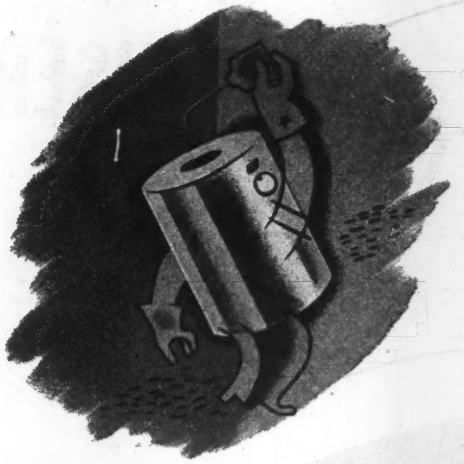
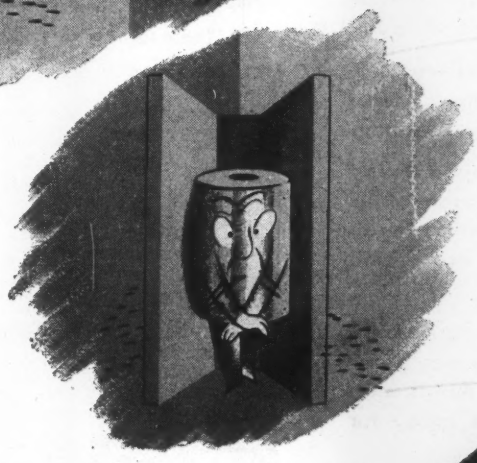
gramix bearings and structural parts cost less . . . last longer

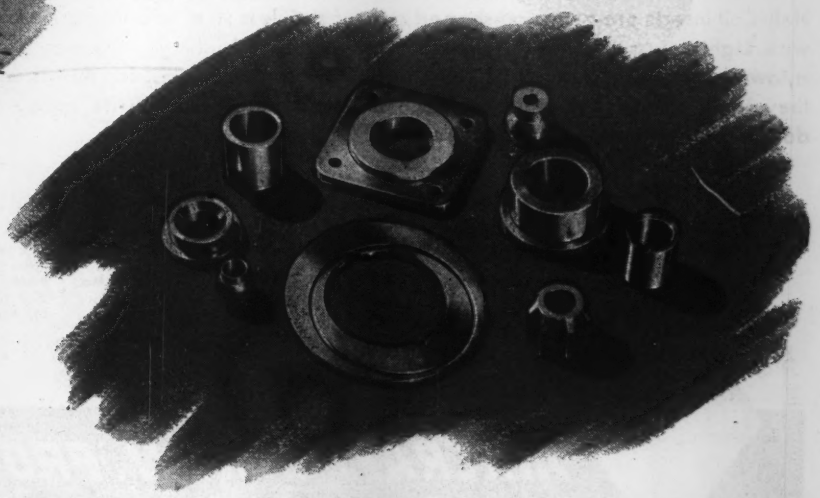


Lubricates Itself. Gramix parts are made by die-pressing powdered copper, iron, and other metals to desired shape and size. Their porosity permits impregnation with any one of a wide variety of lubricants to meet practically every requirement. Self-lubricating Gramix parts lessen maintenance costs, greatly minimize chances of costly bearing failure.

Fine Surface Finish. The extremely high pressures under which the powdered metals are compacted leaves Gramix parts with smooth, unblemished surfaces perfect for sliding or bearing. This eliminates expensive machining and scraping operations, assures you of mechanical parts ready-made for installation.

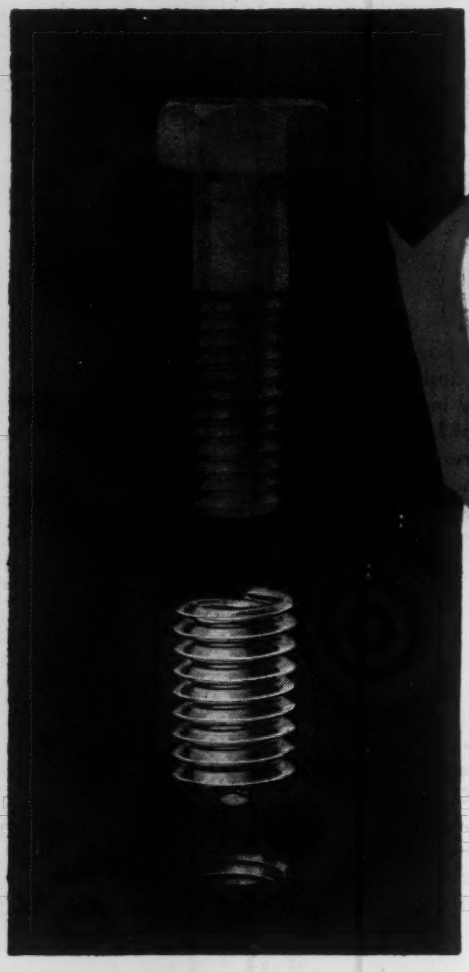


Close Tolerances. Gramix parts can be made to any reasonable tolerance on all dimensions. For example, ID's can be held to .0003". No machining is necessary. In the manufacture of small parts for washing machines, electric fans, sweepers, and other mechanisms, Gramix simplifies production and effects economies which result in greater profits.



Made In Most Shapes and Sizes. Gramix parts can be made in an almost unlimited number of shapes and sizes. They are now delivering dependable performance in such products as refrigerators, pumps, diesel engines, farm implements. Send us a sketch or blueprint of your products, and our engineers will help you determine if Gramix will be of advantage in your manufacturing.

THE UNITED STATES GRAPHITE CO. • SAGINAW, MICHIGAN



Heli-Coil
SCREW THREAD INSERTS

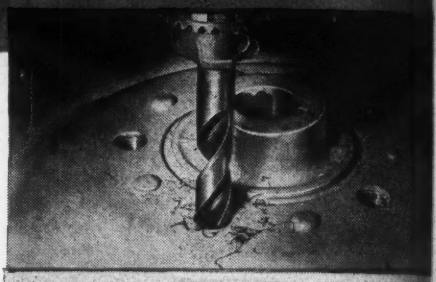
PREVENT WEAR IN TAPPED THREADS
•
RESTORE WORN OR STRIPPED THREADS

Tapped threads in light-metals and other relatively soft materials often wear rapidly under certain conditions. Even in harder metals like cast iron, tapped threads may break down under severe friction and vibration.

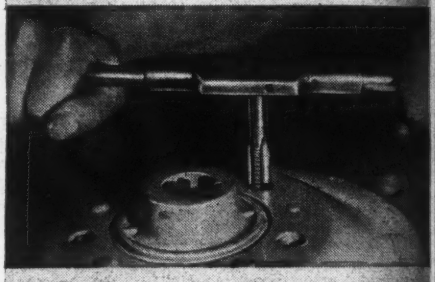
But it is easy to *prevent* tapped thread wear by protecting threads with Heli-Coil Inserts in original installations. It is also easy to *correct* tapped thread wear by repairing worn threads with Heli-Coils in a *simple* maintenance operation

The drawing above shows how Heli-Coil engages the original tapped thread to provide a hard mating surface for the screw or stud. The photographs at the right show a typical maintenance operation with Heli-Coils used to repair worn threads on an axle hub flange. Three simple operations do the job without the use of oversize studs.

Heli-Coil Inserts are precision-shaped coils of stainless steel or phosphor bronze wire. Lighter, less bulky and easier to install than solid bushings, they may prove a low-cost answer to many of your tapped thread problems, for that is what they have been to aircraft construction and maintenance. Write today for detailed information and literature.



1. Drilling out worn thread.



2. Tapping new thread.

3. Inserting Heli-Coil.

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HELI COIL

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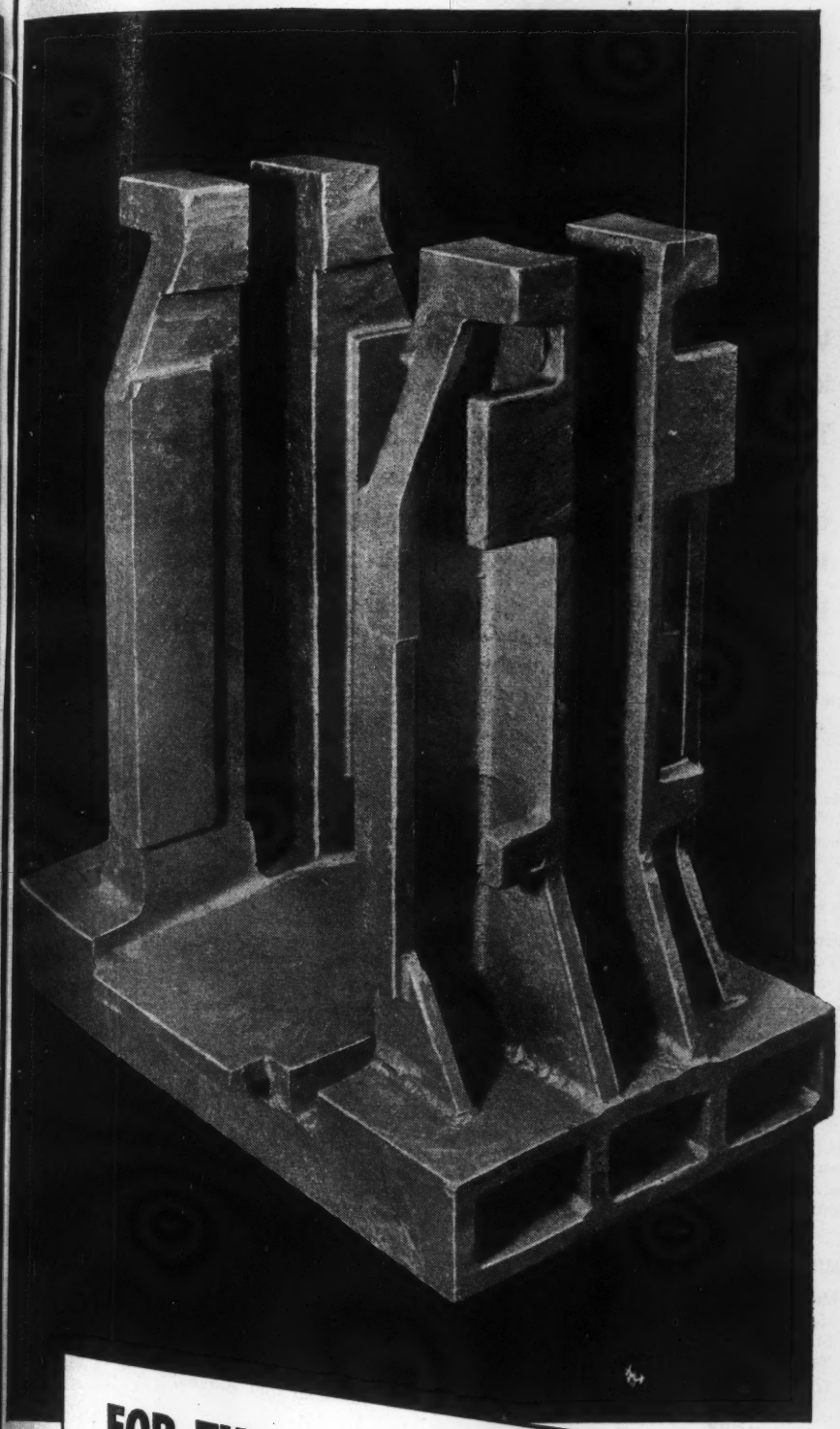

Cast in ONE PIECE

Here's a job that called for plenty of ingenuity on the part of Unitcast Engineers.

The problem—to mold and cast this intricate shape which serves as the main frame of a rod straightener.

The answer—Unitcast met the required specifications for strength, accuracy and uniformity by casting this unit in *one piece!* The finished casting, shown here, is proving highly satisfactory in performance.

Whatever your requirements in steel castings for today's new products and new markets . . . consult with Unitcast! Investigate the superior Quality and Uniformity—*and economy*—of castings produced with automatically controlled accuracy in our modern foundries. Write . . . send blueprints. Unitcast Corporation, Toledo, Ohio.

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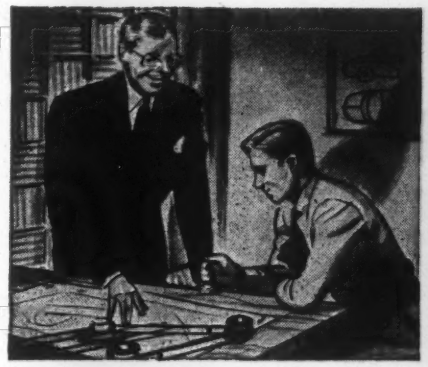
UNITED CINEPHONE CORPORATION

24 NEW LITCHFIELD STREET, TORRINGTON, CONNECTICUT

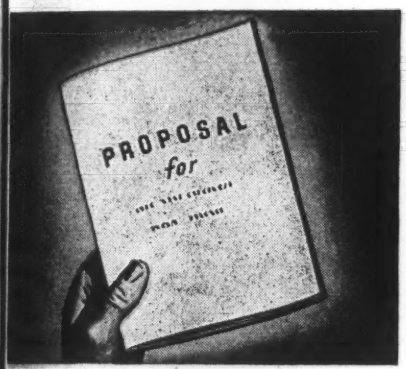
Let Mullins check your new designs

1 The proper use of metal stampings can simplify that new post-war product of yours, and reduce its cost. But where should you use stampings? Let Mullins' stamping engineers help you decide . . .

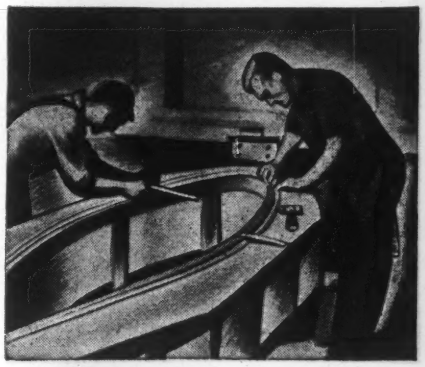


2 Mullins knows how to use pressed metal to best advantage. Intricate castings or forgings can be replaced by lighter stampings of equal strength. Many complicated close-tolerance parts can be made by brazing or welding stampings together . . .

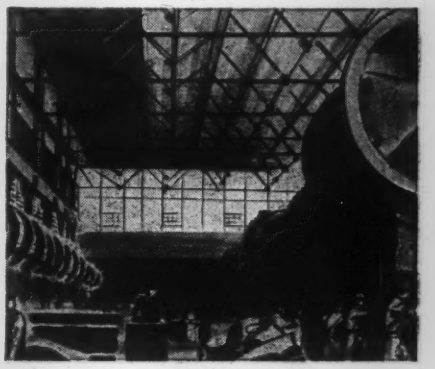
3 These refinements in design will probably change your production set-up. Mullins' engineers can often eliminate several assembly operations by supplying you with pre-fabricated parts . . .



4 If you find you can use Mullins Service, you know in advance exactly what it will cost. Mullins submits a complete production proposal for your approval . . . giving you an accurate check on the savings made possible by stampings . . .



5 Production of parts for your product starts with the making of dies. Here, Mullins' experience is a definite help. Mullins knows how to make dies that eliminate stamping operations, forming complicated parts to close tolerances . . .



6 Some of the largest presses in existence are ready to make your parts in Mullins plants. Mullins can produce any quantity of medium or large size stampings you need, and deliver on a schedule that exactly meets your production plans . . .

Manufacturers of
Youngstown Kitchens by Mullins

Every manufactured article you buy and sell helps maintain national prosperity by keeping men and dollars at work.

Mullins Manufacturing Corporation
Salem, Ohio
Plants at Warren and Salem, Ohio

A day or two spent with Mullins' engineers has shown dozens of manufacturers how to make a good product better, and make it at lower cost. Even if you have a design that "can't use stampings" it may pay you to have us look it over. We have made a good many "impossible" stampings in our 50 years of experience, and in each case the product was improved. We'd like a chance to check your designs before they get too far along. Our engineers are ready to work with you right now. Just tell us what you're going to make and when we can help you with your plans.

Mullins

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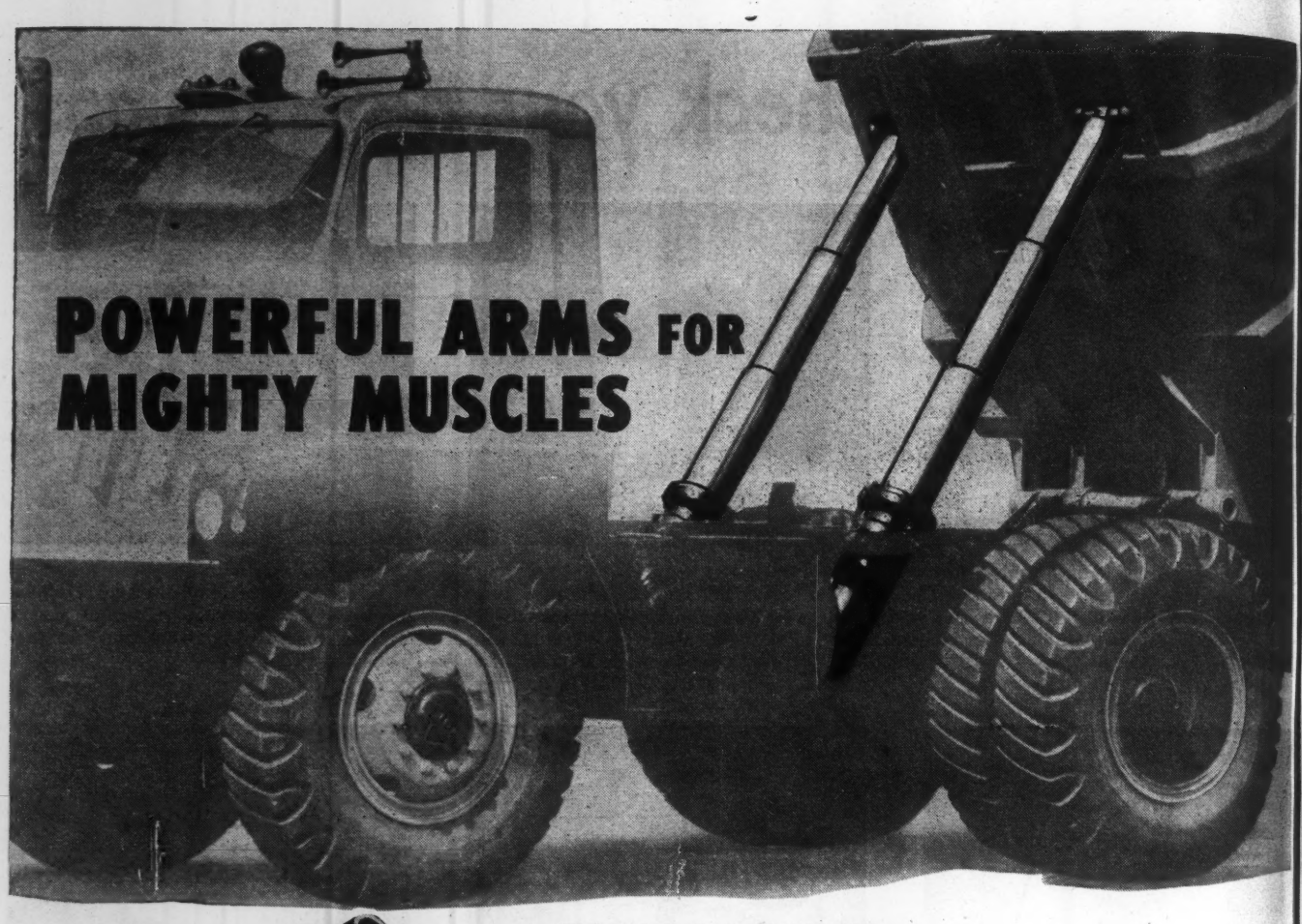
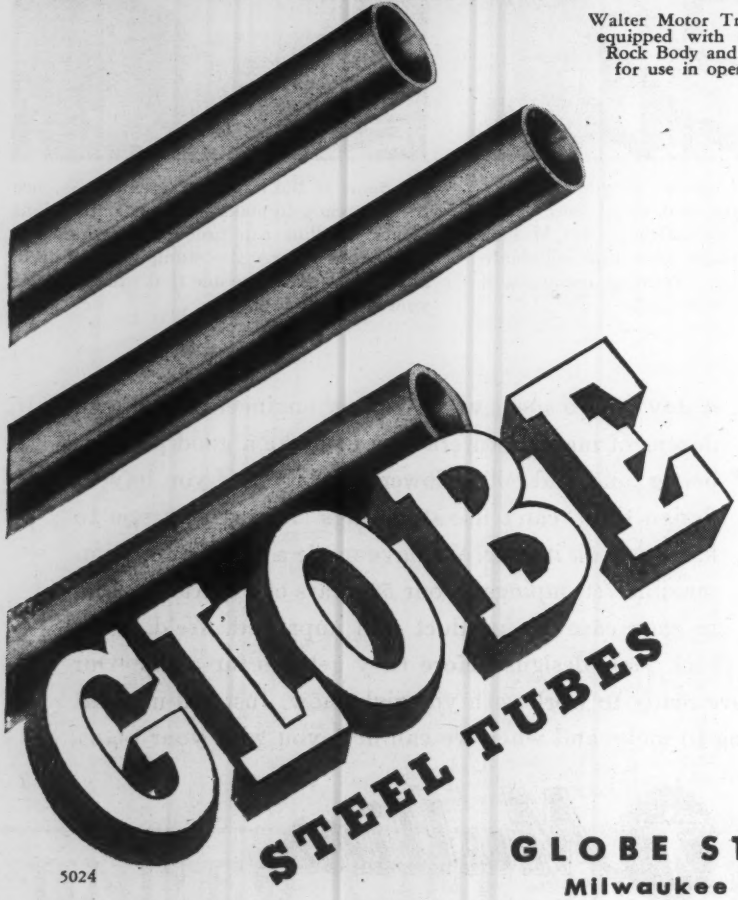
PORCELAIN ENAMEL PRODUCTS



Walter Motor Truck, Model AC-VD, equipped with special 12 yard Heil Rock Body and Twin Telescopic Hoist for use in open pit iron mine handling.



"MECHANICAL muscles" just don't "happen." Hydraulic pressures would be impotent without pressure-resistant channels to confine them. Mechanical tubing of adequate strength is an important part of hydraulic devices. Globe builds mechanical tubing that provides strength with light weight for hydraulic and many structural applications.

Here is another example of Globe's ability to supply tubing in a wide range of sizes, analyses, and types, for a variety of needs. And when you specify "Globe" you are sure of uniformity and quality in tubing —mechanical, pressure, corrosion resistant applications.

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There is no guesswork or "trusting to luck" when you rely on ALEXANDER quality. Every condition peculiar to *your* plant or process has been anticipated and overcome in our laboratories.

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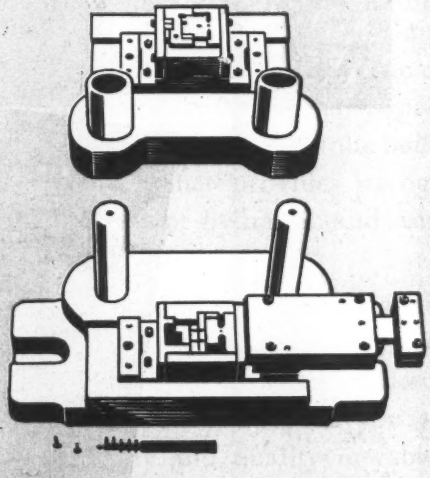
And that's where the tool and die experience and facilities of the Barth Organization fit into the scene!

If you need help in tooling up your product . . if you need the services of experienced product designers . . if you need engineering to reduce production costs, Barth engineers, designers, and tool and die craftsmen are ready to serve you.



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Quiet - Cool -

NEW BALLENTINE SINGLE VALUE CAPACITOR MOTOR

This miniature powerhouse heads the parade of Ballentine Motors now rolling off the production lines and available for prompt delivery.

Like all QUIET Ballentine Motors, the Single Value Capacitor Motor is the result of expert craftsmanship at its best—*precision dynamic balance*—strict adherence to close tolerances. It is especially suitable for built-in applications, as it has no switches—no brushes. Ideal for projectors, fans, and similar applications where high heat losses are not desirable.

Other QUIET Ballentine Motors from 1/1000 to 1/8 H.P. will soon be available.

APPROXIMATE SPECIFICATIONS

Single value capacitor motor. Diameter 3½", Length 3½". Double or single shaft extension. 2 pole—1/20 h.p. 3400 RPM, 4 pole—1/25 h.p. 1700 RPM. Strap type mounting. Cool running, 50% efficiency. Motor parts—rotor and stator available for built-in applications.

RUSSELL ELECTRIC COMPANY

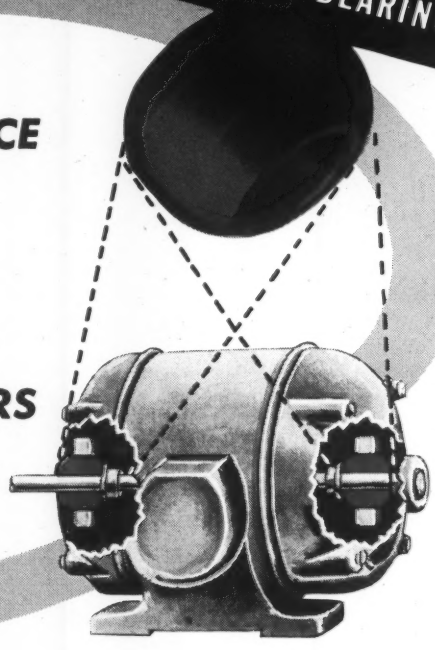
346 WEST HURON ST., CHICAGO 11, ILLINOIS

Manufacturers of **BALLENTINE MOTORS**

SELFLUBE

SELF-ALIGNING SPHERICAL TYPE BEARINGS

INCREASE PERFORMANCE AND PROLONG SERVICE LIFE of FRACTIONAL H.P. MOTORS



FREEDOM from lubrication difficulties in fractional horse power motors is assured by the installation of Selflube Self-Aligning Spherical Type Bearings. These are porous bronze bearings made by the powder metallurgy process. Their porous structure maintains a reservoir of oil, obtained by pre-lubrication, and meters it to the bearing surface as needed during operation. In many installations it lasts the life of the equipment, and needs no further attention.

In addition to better performance and prolonged service life, Selflube Bearings offer substantial savings to the motor manufacturer. They are made within close dimensional limits in dies that give the bearings a high burnish. Their uniformity eliminates hand fitting, and they require no reaming or other machine work. A slot or groove can be incorporated on the spherical diameter for a key to prevent the part from spinning in a spherical seat without interferring with its self-aligning action. Selflube is truly "The Bearing with a Million Oil Wells." Write for complete information.

PRODUCTS USING SELFLUBE SELF-ALIGNING SPHERICAL TYPE BEARINGS

- ELECTRIC MOTORS
- VACUUM CLEANERS
- SEWING MACHINES
- BLOWERS AND FANS
- KITCHEN MIXERS
- DOMESTIC MACHINES
- CLOCKS
- REFRIGERATORS
- WATER PUMPS
- BUSINESS MACHINES

• • •

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Manufacturers of Precision Molded Parts

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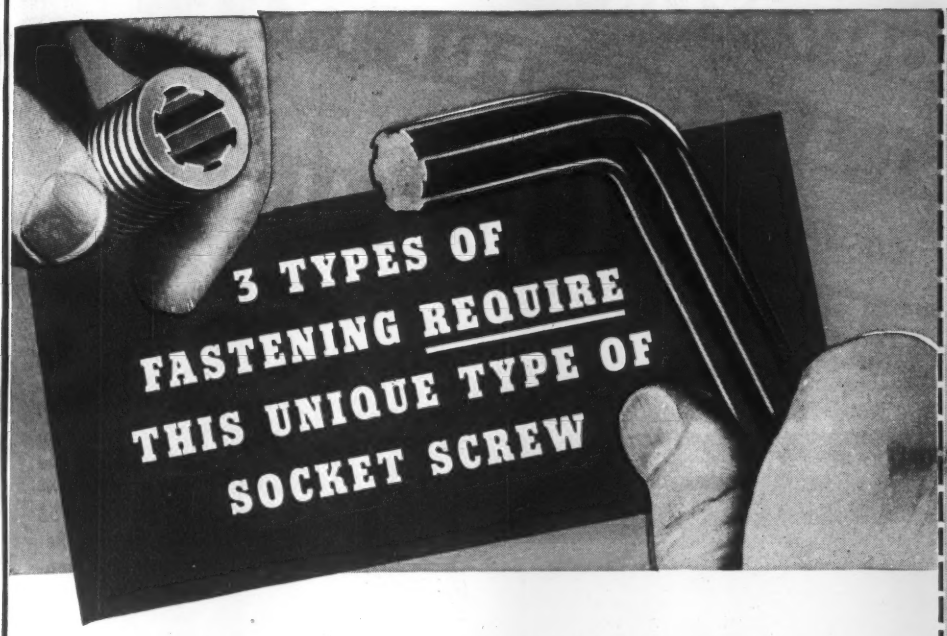


3 TYPES OF FASTENING REQUIRE THIS UNIQUE TYPE OF SOCKET SCREW

Only the BRISTO "Multiple-Spline" meets all requirements for easy assembly, vibration resistance, easy disassembly

Compare the wrenching forces applied to a BRISTO "Multiple-Spline" and to a Hex . . . and you'll understand why more and more designers specify BRISTO for fastening these three classes of products:

1. Products with awkwardly-located fastening points
2. Products exposed to severe vibration
3. Products subject to frequent disassembly

Notice how the spline-shaped socket of the BRISTO socket screw mates with the key. The key *pulls* the screw instead of *pushing* it around. No expanding pressure tending to round out or burst the walls — especially in the smaller sizes. Precision-made, close-tolerance "Multiple-Spline" screws set up easier, faster and farther. And come out easier, too . . . at a flick of the key.

You can specify BRISTO "Multiple-Spline" screws in cap or set screw styles in sizes starting at #4 wire.

And for applications calling for hex socket screws, the Bristol Hex gives you the benefits of the same cold-forged toughness and close dimensional tolerances as BRISTO "Multiple-Spline" Screws.

BRISTO SET & CAP SCREWS

WHY "MULTIPLE-SPLINE" MEANS

TIGHTER

NO EXPANDING PRESSURE; THE KEY PULLS THE SCREW AROUND

The BRISTOL Company
MILL SUPPLY DIVISION

5-83

GET SPECIFIC FACTS ON BRISTO "MULTIPLE-SPLINE" FOR YOUR APPLICATION

- ☐ cream separators
- ☐ dental equipment
- ☐ die cutting and stamping machinery
- ☐ Diesel engines
- ☐ dynamos
- ☐ electric fans
- ☐ electric razors
- ☐ electric machinery
- ☐ elevators
- ☐ generators
- ☐ hydraulic machines
- ☐ instruments
- ☐ machine tools
- ☐ match machinery
- ☐ meat machinery
- ☐ meters
- ☐ oil well machinery
- ☐ paper mill machinery
- ☐ portable electric tools
- ☐ postage meters
- ☐ printing presses
- ☐ pumps
- ☐ punches
- ☐ radios
- ☐ refrigerators
- ☐ screw machines
- ☐ textile machinery
- ☐ time clocks
- ☐ vacuum cleaners
- ☐ vending machines
- ☐ washing machines

Other applications .....

Name .....

Company .....

Address .....

THE BRISTOL COMPANY
Mill Supply Division
122 Bristol Rd., Waterbury 91, Conn.

Please send me literature describing Bristo "Multiple - Spline" Socket Screws. I'm interested in the following applications:

- ☐ adding and computing machines
- ☐ addressing machines
- ☐ air compressors
- ☐ air conditioning apparatus
- ☐ aviation engines
- ☐ aviation metal parts
- ☐ blowers
- ☐ cameras
- ☐ cash registers

Only the "B-LINE" has the right socket screw for every application

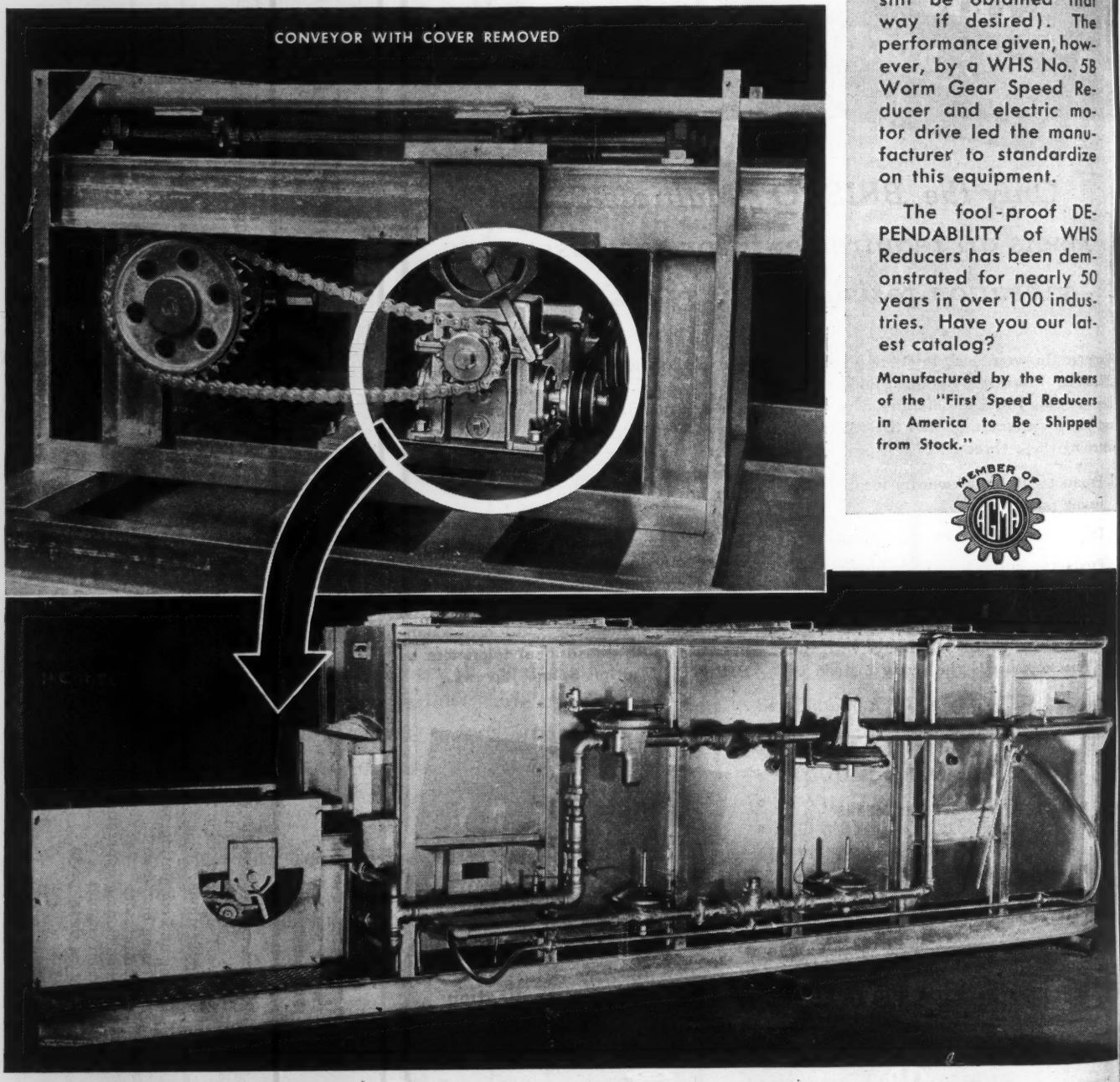
FURNACE CONVEYOR OF A MOST SUCCESSFUL TYPE *is operated by a* WHS SPEED REDUCER

This "Campion Shuffle Hearth" . . . a conveyor for transporting work through a heat treating furnace . . . was formerly designed to operate with compressed air (and can still be obtained that way if desired). The performance given, however, by a WHS No. 5B Worm Gear Speed Reducer and electric motor drive led the manufacturer to standardize on this equipment.

The fool-proof DEPENDABILITY of WHS Reducers has been demonstrated for nearly 50 years in over 100 industries. Have you our latest catalog?

Manufactured by the makers of the "First Speed Reducers in America to Be Shipped from Stock."

MEMBER OF AGMA



WINFIELD H. SMITH, Inc.

16 ELTON STREET . . . SPRINGVILLE . . . ERIE COUNTY . . . NEW YORK

BANDING THE BIG SHELLS

A "MARRIAGE CEREMONY" PERFORMED WITH HELE-SHAW FLUID POWER

Projectiles are fitted with "driving bands." The main, but not the only, function of these bands is to rotate the shell.

Years ago the bands were rolled on, later pressed on mechanically. Now most bands are squeezed on hydraulically. One slight pull on a 2-way valve lever and powerful "fingers" compress the ring about the shell. Another pull and springs return the plungers to "open", ready for the next squeeze. Pressure at two or three shell positions and the job is done—fast!

Hele-Shaw Fluid Power with its high oil pressure, ease of control and operation, is made to order for machines of this type. Learn all of the advantages of Hele-Shaw Fluid Power and go hydraulic on your next job.

THE HELE-SHAW

Fluid Power

PUMP

OTHER Æ PRODUCTS:
Æ-TAYLOR AND PERFECT SPREAD STOKERS, MARINE DECK AUXILIARIES, LO-HED HOISTS DIAMOND FACE GRINDERS

AMERICAN ENGINEERING COMPANY

2502 ARAMINGO AVENUE, PHILADELPHIA 25, PA.

Copyright 1945, American Engineering Company

Co-ordination

Co-ordinating research with manufacturing, Solar developed the above motion picture equipment to record entire welding operations under controlled conditions.

IN GOLF, complete co-ordination of skill and knowledge set the champion apart from the rest. So it is in fabricating stainless steel. This too, requires co-ordination of specialized skill and knowledge that only years of engineering, designing and fabricating can achieve.

Solar's universally recognized "know-how" in all stainless steel forming techniques, from deep drawing to precision casting, is a result of many years experience. Solar designed and built the first successful stainless steel airplane exhaust system for the Navy in 1931. And through all of the remarkable developments of the aircraft industry, including jet and gas turbine engines, Solar remains the industry's leader in producing heat and corrosion resistant products.

If your product or its parts can be built better with stainless, take advantage of this wide experience by sub-contracting this work to Solar. A letter to Solar will establish the contact.

ARMY ★ E NAVY
ARMY ★★ E ★★ NAVY

SOLAR

HIGH TEMPERATURE ALLOY PRODUCTS

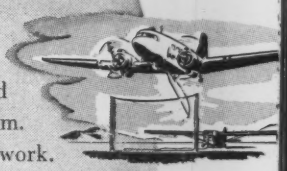
SOLAR AIRCRAFT COMPANY SAN DIEGO 12, CALIF. DES MOINES 5, IA

In Springs—

it's the X-Dimension that gives a Glider and You a Lift

Ever hear of the X-Dimension of a Spring? Probably not. But, sure as you're born it's there, in every spring. Take, for instance, the intriguing what-is-it pictured below. It's a glider release spring, an assembly which holds the pick-up rope until the parent plane hitches on—then let's go at a precise jerk on the towline.

If Hunter had only manufactured and delivered dependable glider release springs on time and in needed quantities, its job would have been satisfactory. But Hunter invented the device for All American Aviation, Inc., and assigned the patents to them. That's the X-Dimension at work. It's also at work in such pioneering efforts in spring manufacture as control gaging and statistical methods in quality control. It's your guarantee of good springs, your insurance against failures and customer complaints. It's *more* than you bargained for—in springs.



HUNTER
Science in Springs

HUNTER PRESSED STEEL COMPANY
Lansdale, Pennsylvania
SPRINGS • METAL STAMPINGS • WIRE FORMS
MECHANICAL AND ELECTRICAL ASSEMBLIES

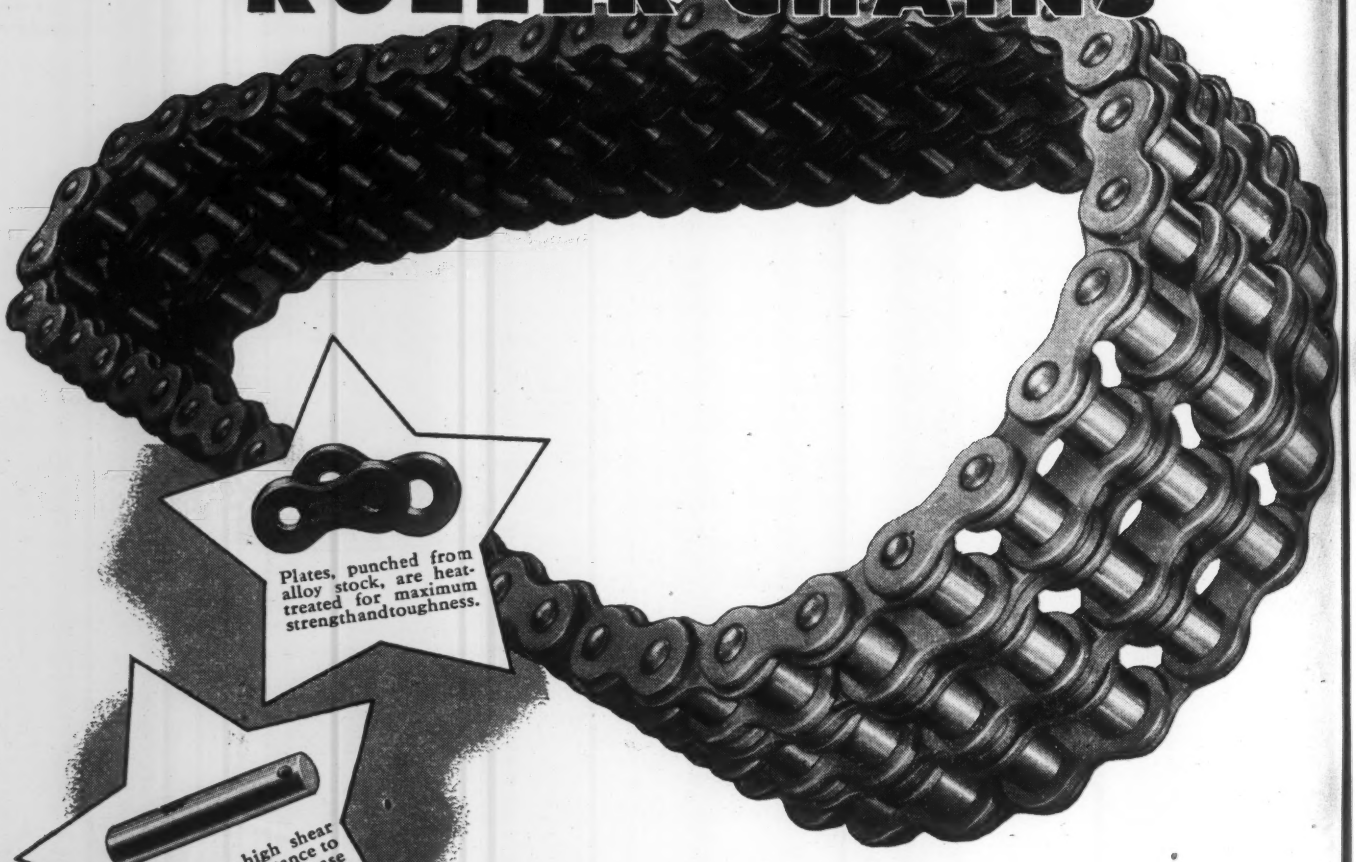
MEMO TO PURCHASING MEN—

• Next time your engineers hand you a tough spring procurement job, let Hunter help you get your money's worth.

The Four-Star Construction of

WHITNEY

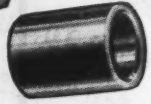
ROLLER CHAINS



Plates, punched from alloy stock, are heat-treated for maximum strength and toughness.

Pins have high shear value and resistance to wear. They are case hardened and center-less ground.

Bushings are die drawn from selected alloy steels, properly case hardened; held to close limits.

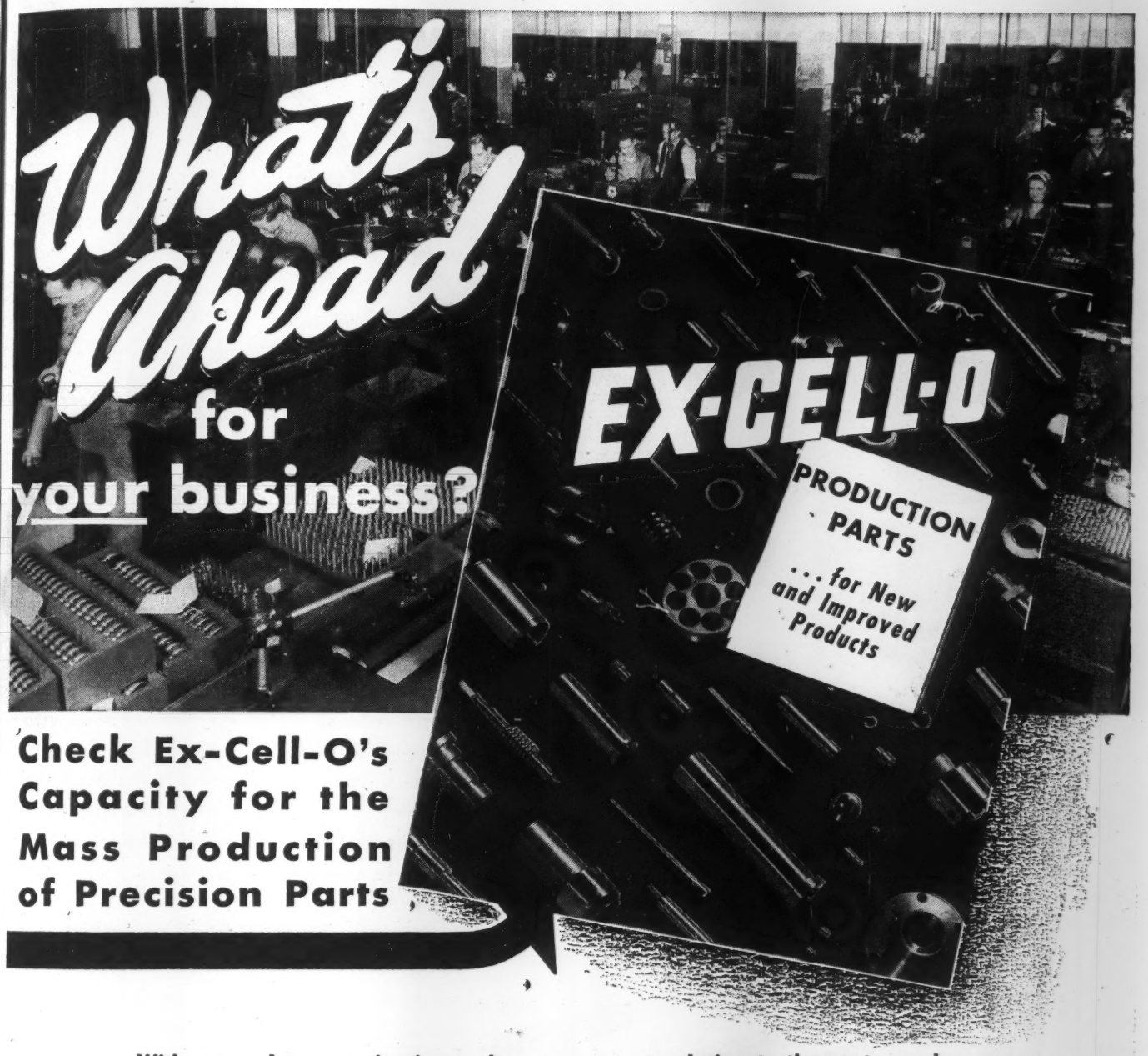


Rolls, die drawn or turned from solid alloy bars, are heat-treated for toughness.

Precision parts accurately joined to insure powerful, positive drive and delivery of full rated machine capacity. For top performance fit *all* your production machines with Whitney Roller Chain Drives, and *be sure* of the right combination for a perfect power drive.

The WHITNEY CHAIN & Mfg. Co.

HARTFORD, CONNECTICUT



Check Ex-Cell-O's Capacity for the Mass Production of Precision Parts

With a complete organization under one responsible management . . . *an organization built upon years of varied engineering experience, modern machining methods and heat treat facilities, and practical inspection staffs* . . . Ex-Cell-O probably has the exact solution to the parts production problem you face. The above folder illustrating Ex-Cell-O's complete parts production facilities will be sent you upon request. Write or wire Ex-Cell-O today and ask for Ex-Cell-O Bulletin No. 36151.

XLO
EX-CELL-O *for* PRECISION

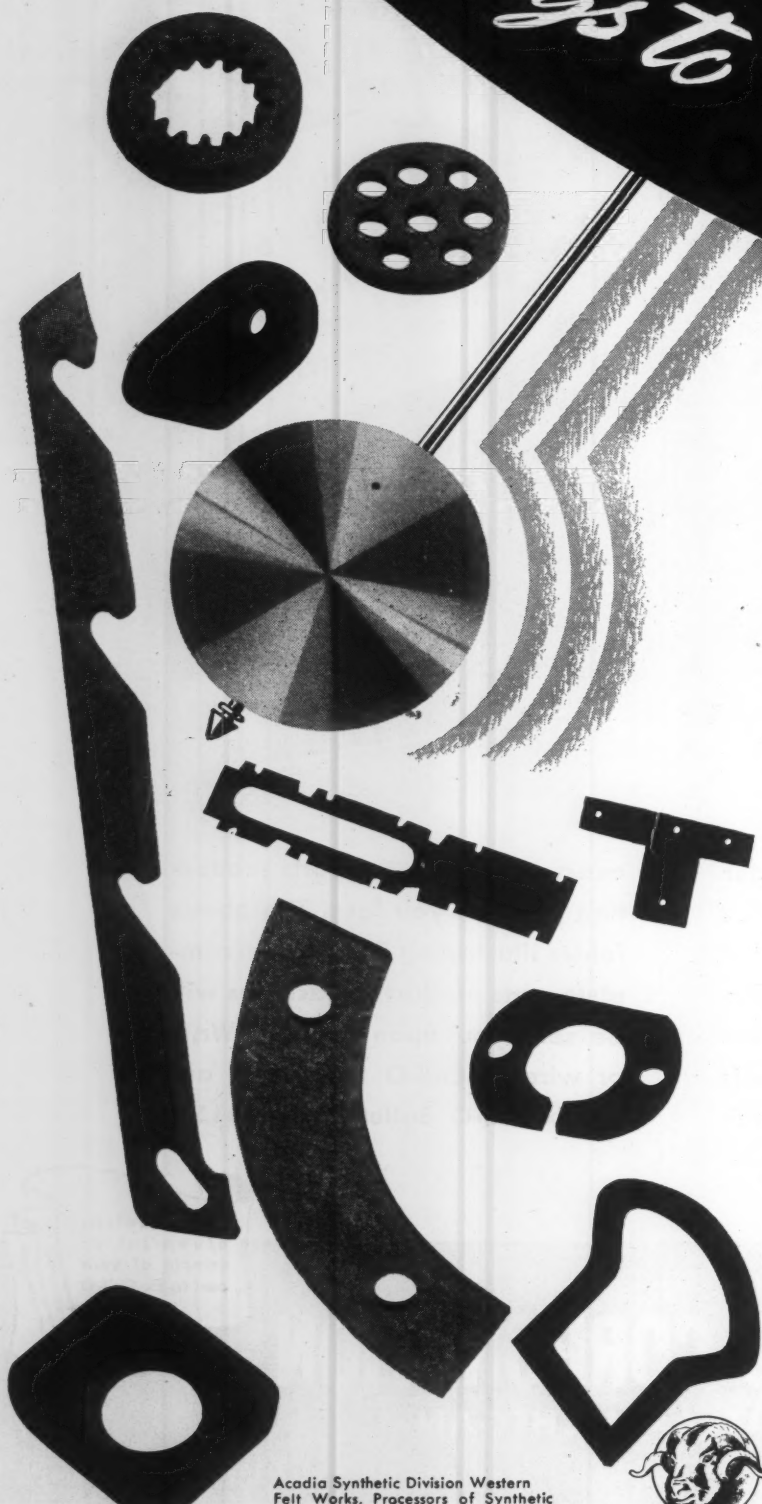
Send sketch, blueprint or sample of your part to Ex-Cell-O

EX-CELL-O CORPORATION

DETROIT 6, MICHIGAN

PRODUCTION'S PENDULUM

Swings to WESTERN Felt



In new shapes—new forms—felt is replacing many critical materials—oftentimes with no more difficulty than re-writing the specifications on a blueprint. Not infrequently, such changes are merely a "swing-back" to felt, used originally, but replaced temporarily in pre-war days by a less satisfactory material then plentiful.

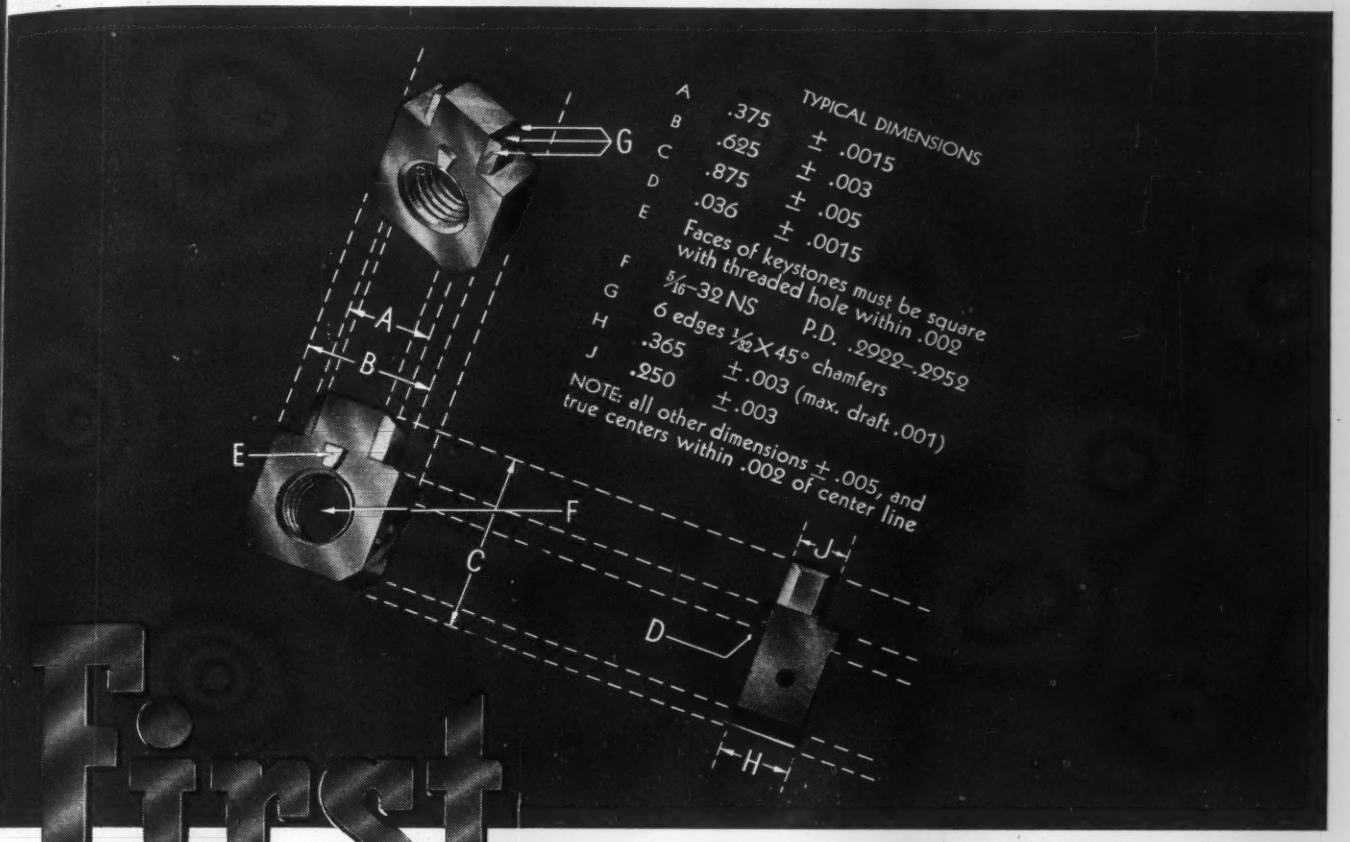
Western Felt fits every specification that calls for resiliency, flexibility, compressibility and resistance to oil, water, heat and age. Finished to very close tolerances, this felt holds its shape perfectly without fraying or ravelling. Western Felt is usable for cushioning shock, sound deadening, weight reduction, killing vibration and hundreds of other purposes.

Western Felt Works engineers are ready, on invitation, to talk over your production problems and point out how felt—in an appropriate grade—may be used to replace many hard-to-get, slow-delivery materials. *Write us today.*

WESTERN FELT WORKS
4035-4117 OGDEN AVENUE • CHICAGO 23, ILLINOIS
Branches in All Principal Cities

Acadia Synthetic Division Western Felt Works, Processors of Synthetic Rubber, Sheets, Extrusions, Molded Parts.

WESTERN Felt
Largest Independent Manufacturers and Cutters of Wool, Hair and Jute Felts



First in a series of case histories on a new process for mass production of precision castings

To assist engineers and executives who are responsible for the creation and development of new products and the improvement of present designs, we present the first of a series of factual data on CHEMICAST Precision Castings . . . taken from our laboratory and production records.

Speed . . because of an urgent military necessity . . was essential in producing the above illustrated part. Delivery of 5,000 duplicate pieces . . to specifications shown and with strength equal to Tobin Bronze . . had to start within 45 days.

Ordinary methods would have required 9 straddle milling operations . . plus costly jigs to hold pieces during these operations. Possible delay might prove costly . . and the method would be.

All military requirements were met or exceeded . . by using the CHEMICAST Process. An additional 40,000 of these pieces were delivered on time . . and more economically.

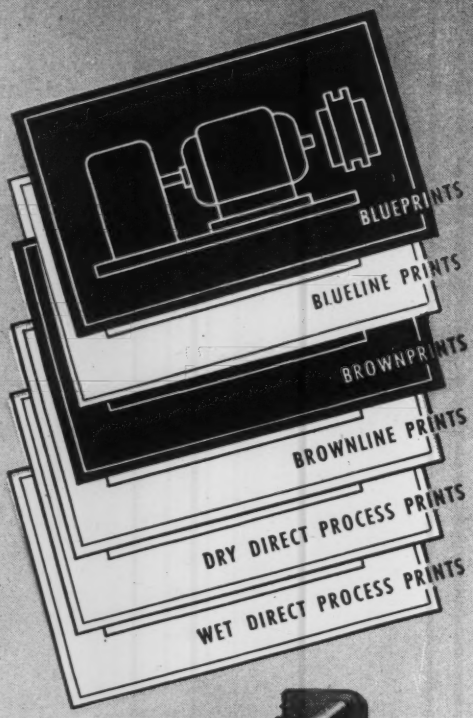
In casting a small part, such as this one, where all or most of the machining can be eliminated, it is possible to use Chemibrass. This metal combines high tensile strength, high elongation, corrosion resistance and smooth finish. For many uses, it can replace steel and its necessary plating.

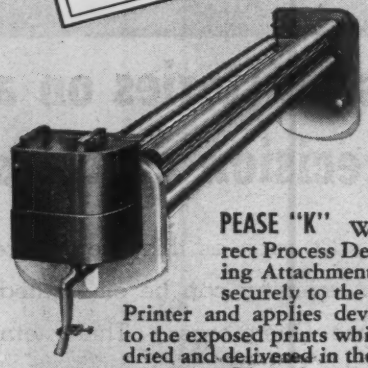
If your products require small, non-ferrous, metal parts entailing numerous machining operations, send sample part . . . or blueprint to us. Your inquiry will receive prompt attention. Write CHEMICAST DIVISION, Whip-Mix Corporation, Louisville 8, Kentucky.

PRECISION CHEMICAST CASTINGS

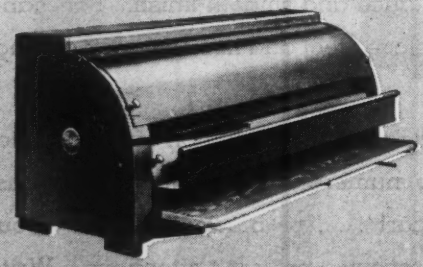
Start right with

PEASE BLUEPRINTING MACHINES AS BASIC EQUIPMENT FOR YOUR TRACING REPRODUCTION DEPARTMENT

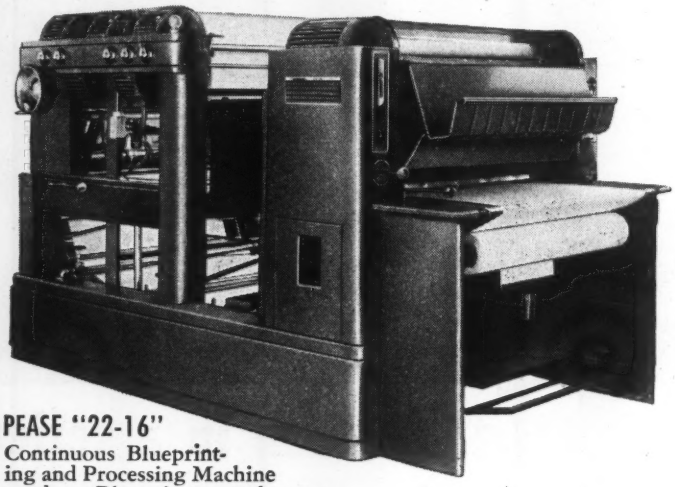




PEASE "K" Wet Direct Process Developing Attachment bolts securely to the top of Printer and applies developer to the exposed prints which are dried and delivered in the same manner as Blueprints.



PEASE "700" Dry Direct Process Developing Unit is a table style, ammonia fume machine for developing the prints after exposure in the Printer. It is continuous in operation and has two developing speeds, 4 feet and 8 feet per minute.



PEASE "22-16"
Continuous Blueprinting and Processing Machine produces Blueprints at 20 feet per minute. Made in 42-inch and 54-inch sizes.

START with Pease "22-16" (above), or any other Pease Continuous Blueprinting and Processing Machines, as basic equipment, and you are ready to produce Blueprints, Blueline prints, Brownprints (Negatives) and Brownline prints.

ADD a Pease "700" Developer (left) for making Whiteprints (Dry Direct Process) . . . and a Pease "K" Attachment (left) to the printer for making Wet Direct Process Prints.

THE RESULT is a tracing reproduction department capable of efficiently producing six different kinds of high quality prints in volume and at lowest cost per square foot of finished prints.

Send for descriptive literature and prices.

THE C. F. PEASE COMPANY
2606 WEST IRVING PARK ROAD • CHICAGO 18, ILLINOIS

Pease

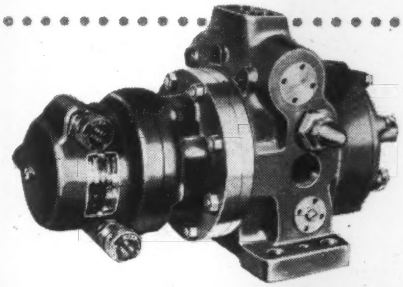
BLUEPRINTING MACHINES FOR ALL KINDS OF TRACING REPRODUCTIONS

IMPROVE YOUR DESIGNS!

WITH THIS SUNDSTRAND HYDRAULIC EQUIPMENT

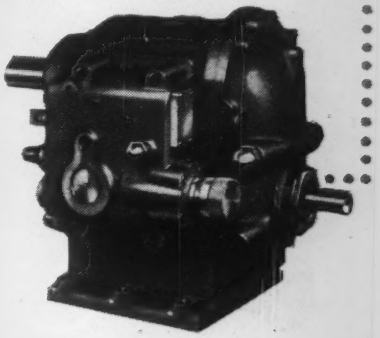
Here's modern equipment for modern hydraulic circuits. With it you can easily get a wide range of infinitely variable speeds and feeds to suit design and performance requirements of modern materials in *both* cutting tools and work. Either standard elements for your own circuit designs or complete circuits built into self-contained units are available.

PUMPS

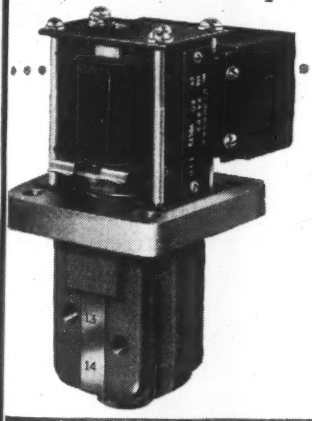


Standard constant displacement pumps, without relief or control valves are available in capacities from 2 to 15 G.P.M. With relief valve and directional control valve they are available in capacities from 4 to 18 G.P.M. . . . Our PWX pump (illustrated) is a combination variable displacement, piston and constant displacement type pump. Both feed and traverse rates are obtainable from this pump.

HYDRAULIC TRANSMISSIONS



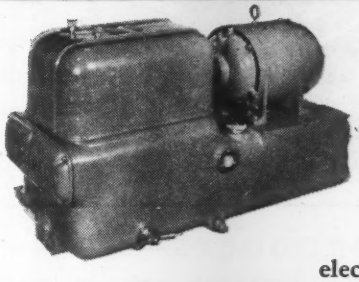
Providing a variable speed left or right hand rotation with neutral are available. Output speeds from 10 to 2400 r.p.m. are obtainable. Write for free descriptive bulletin.



VALVES

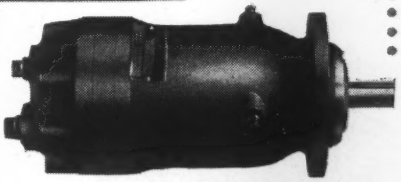
Relief valves, pilot valves, directional control valves, solenoid valves, pressure-reducing valves and cycle valves are all obtainable. Shown, is a single solenoid operated valve.

COMPLETE SELF-CONTAINED HYDRAULIC UNITS



These complete units contain pumps, control valves, electric drive motor and oil reservoir. They are compact units which can be placed in convenient positions. Designed to suit your equipment, they save considerable design and assembly time.

FLUID MOTORS



Both constant and variable displacement type motors are available. The simplicity of design and application of these motors makes it possible to apply this type of power transmission wherever a wide speed range with smooth speed is required. Write for free descriptive bulletin.

FREE DESIGN DATA

Design details covering pumps, valves, fluid motors and hydraulic transmissions are covered in this set of four bulletins. Write for your copies today. Ask for bulletins D-1.

SUNDSTRAND MACHINE TOOL CO. ROCKFORD, ILLINOIS U.S.A.

SUNDSTRAND PUMP DIVISION

2559 ELEVENTH STREET • ROCKFORD, ILLINOIS

FUEL UNITS • HYDRAULIC PUMPS • TRANSMISSIONS • FLUID MOTORS • VALVES and CONTROLS

...ected for the War Planes of yesterday... Ready for the Peace Planes of today!

NEW materials . . . NEW techniques . . . NEW know-how . . . yesterday available only for high priority war planes and equipment—NOW you can have them, to apply to your current design and production problems. Whenever you have a problem where you think NON-metallics may be the answer . . . let C-D technicians study it with you. The proper application of these new C-D materials, techniques, and know-how may help you speed-up reconversion, improve product performance, cut production costs. Wire . . . phone or write our nearest office . . . or send us your blue prints.

C-D PRODUCTS

The Plastics

DILECTO—A Laminated Phenolic.

CELORON—A Molded Phenolic.

DILECTENE—A Pure Resin Plastic Especially Suited to U-H-F Insulation.

HAVEG—Plastic Chemical Equipment, Pipe, Valves and Fittings.

The NON-Metallics

DIAMOND Vulcanized FIBRE

VULCOID—Resin Impregnated Vulcanized Fibre.

MICABOND—Built-up Mica Electrical Insulation.

Standard and Special Forms

Available in Standard Sheets, Rods and Tubes; and Parts Fabricated, Formed or Molded to Specifications.

Descriptive Literature

Bulletin GF gives Comprehensive Data on all C-D Products. Individual Catalogs are also Available.

Continental·Diamond

Engineered Non-Metallics

RAC-46

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Continental-Diamond FIBRE COMPANY

Established 1895 . . Manufacturers of Laminated Plastics since 1911—NEWARK 46 • DELAWARE

This Book May Help You Pick
THE FINISH FOR YOUR NEW PRODUCTS

Polymerin Finish Dries Faster, Stays Beautiful Longer!

"The Facts on Polymerin" describes the two-way competitive advantages you can gain by finishing your postwar products with durable, speed-bake Polymerin.*

Polymerin is an organic baking enamel with unusual properties of durability and resistance . . . properties which may be varied to meet the individual requirements of such products as refrigerators, stoves, washing machines, bicycles, lamps, fluorescent reflectors, artificial tile, kitchen and under-sink cabinets, gasoline pumps, venetian blinds, vending machines and other appliances.

Polymerin stays beautiful longer! Impartial tests have shown that Polymerin is nine times harder to chip than ordinary enamels. And Polymerin—the original speed-bake finish—offers production advantages, too. For Polymerin's faster drying results in savings which can help you keep your finishing costs low!

Use the coupon below to get your free copy of "The Facts on Polymerin", a 32-page booklet which presents clearly and factually the sales and production advantages of a Polymerin finish. This information-packed booklet is yours for the asking. Act today!

*Reg. U. S. Pat. Off.

POLYMERIN

The Original Speed-bake Finish

A PRODUCT OF AULT & WIBORG

DIVISION OF INTERCHEMICAL CORPORATION

MD-12-45

Ault & Wiborg Division of Interchemical Corporation
Empire State Bldg., New York 1, N. Y.

Please send, without obligation, a free copy of "The Facts on Polymerin"—the book that shows how a Polymerin finish can increase sales and reduce finishing costs.

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*Company*_____

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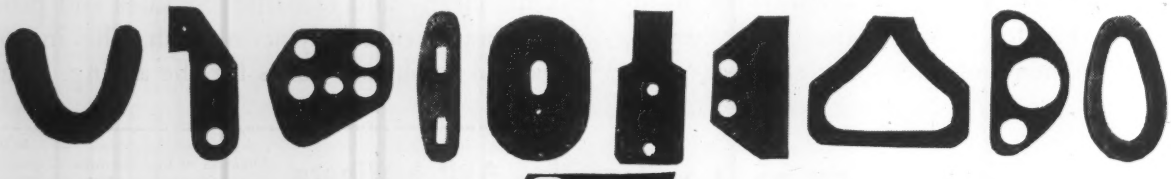
YOU'LL NEVER GET A KICK OUT OF THIS!

The man with the shotgun was plenty tired of the drubbing his shoulder took every time he fired. Then his dealer sold him a recoil pad of resilient Spongex* cellular rubber!

It was the old story of the thump and rattle and jar that wears on both product and owner . . . the cause of premature old age in products —from vacuum cleaners to automobiles. If you've been hunting for a shock absorbing material that will make your product vibration-free, more salable—think of Spongex.

The way it goes in and licks any number of tough product problems has spread its use into hundreds of applications for cushioning, sealing, insulation, sound dampening, gasketing, protection against dust, moisture, gases. Can be made in sheets, pads, slabs, cord, tubing, strips, molded forms and die-cut shapes.

We are operating at peak capacity on industrial production and may not be able to produce what you need for some time—perhaps not until crude rubber is plentiful. However, if your need is urgent, write us and we shall try to help you. Sponge Rubber Products Company, 122 Derby Place, Shelton, Conn. Sales Offices: New York, Chicago, Detroit, Washington.

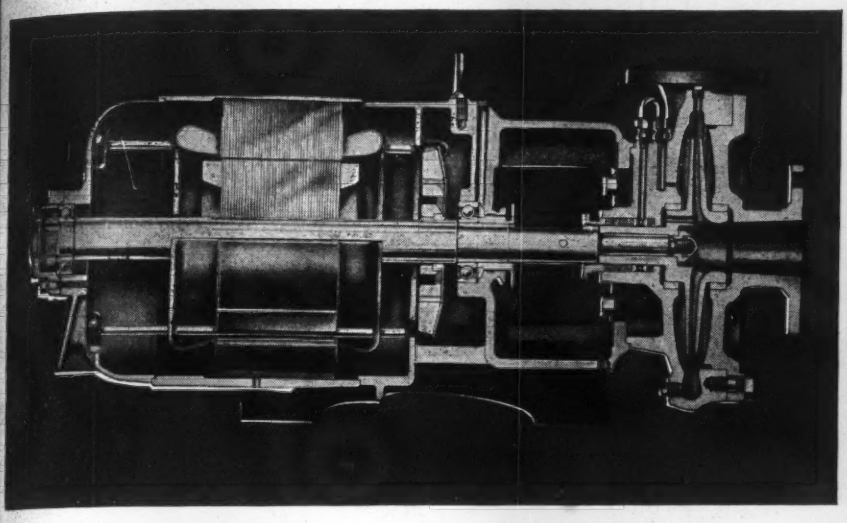


SRP

SPONGE RUBBER PRODUCTS CO.

SPONGEX* CELL-TITE* *TRADE MARK REG U.S. PAT. OFF. TEXLITE TEXLOCK

PUMP AND MOTOR...



Balanced on a Single Support

Simple, balanced design stands out in every feature of Worthington Monobloc Centrifugal Pumps. You can see it in the sturdy one-piece base, motor end bell and pump bracket... in the extra large diameter shaft that prevents eccentricity in any moving part . . . in the short distance between pump and motor . . . in the perfect mating of pump and motor ratings.

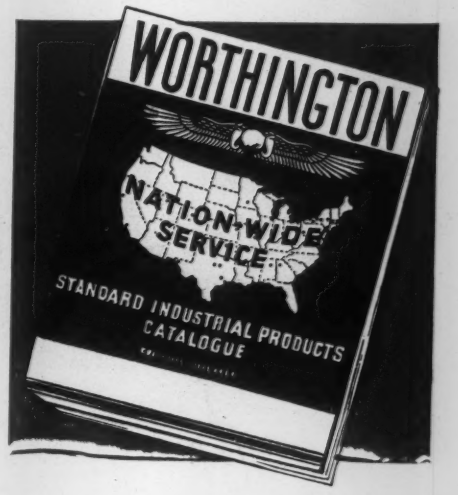
Add these features together and you see why alignment is true and permanent . . . why operation is quiet, service is efficient and life is long . . . why space and installation time are saved.

THE FIRST COMPLETE LINE

Remember—Worthington, first to manufacture a complete line of electric-driven centrifugal pumps of Monobloc design that are truly balanced units . . . planned and mated on the drawing board, is your surest source of the one right unit for your exact requirements. Styles and sizes range in capacities to 1600 G.P.M., in heads to 500 ft., in motor H.P. from ¼ to 60.

For complete specifications and ratings, write for Bulletins W-321-B14 and W-321-B15. *Worthington Pump and Machinery Corporation, Merchandising Division, Harrison, N. J.*

QUICK FACTS ON WORTHINGTON MONOBLOC PUMPS



...in this 180-page catalog

26 pages of the Worthington Standard Industrial Products Catalog go into great detail on the use of Monobloc Centrifugal Pumps for water supply, boiler feed, circulation, condensate return and other applications.

Composite rating tables tell at a glance the one right pump for your problem. Tables of dimensions simplify the job of fitting it into your design.

DATA ON OTHER PRODUCTS

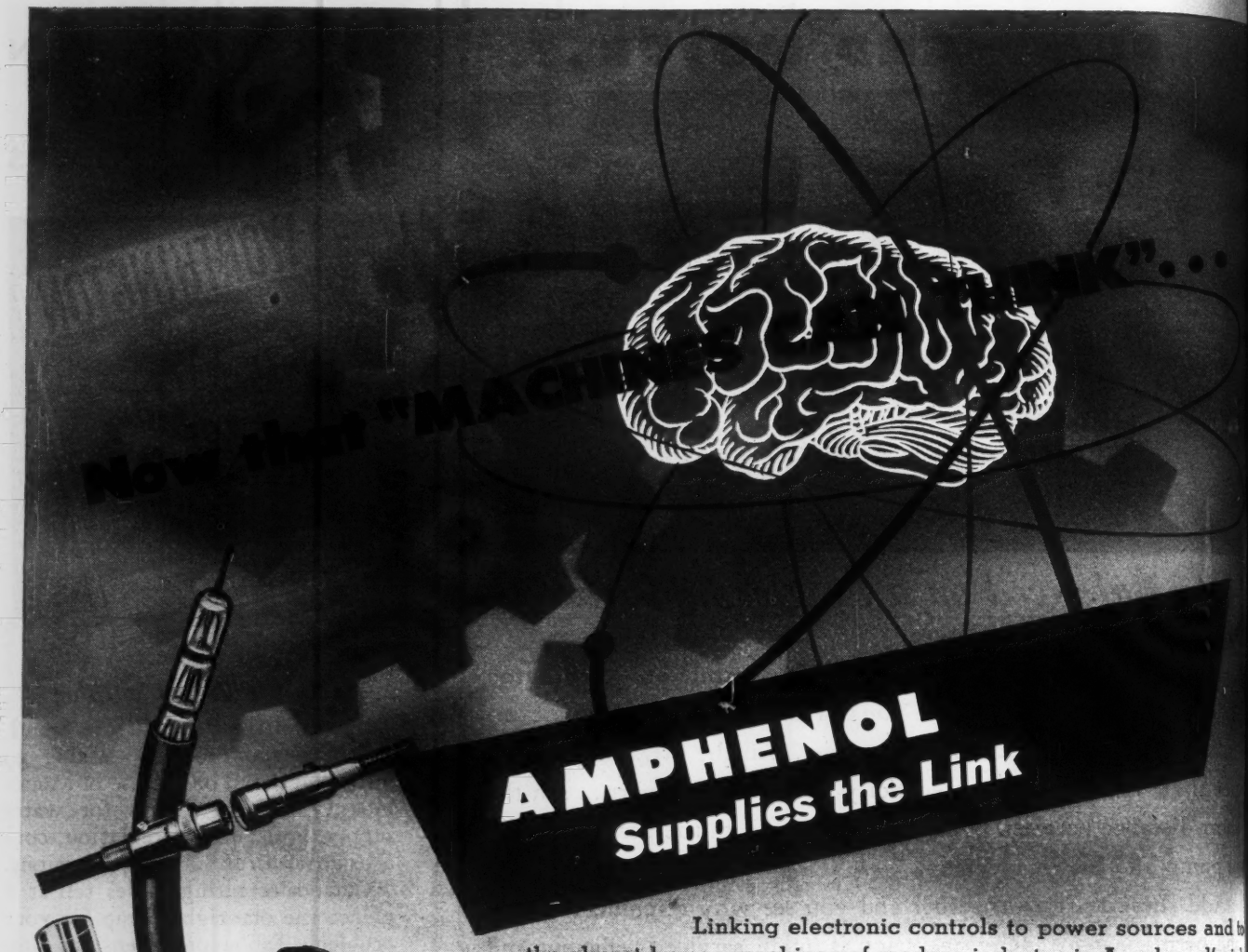
This conveniently-tabbed catalog goes into equal detail on other centrifugal, power, rotary and steam pumps, air compressors, vacuum pumps and liquid meters.

You'll find its engineering data, useful formulae, charts, rating tables, etc. invaluable in all phases of product design. Write for a free copy today. *Worthington Pump and Machinery Corporation, Merchandising Division, Harrison, N. J.*

WORTHINGTON

B5-14

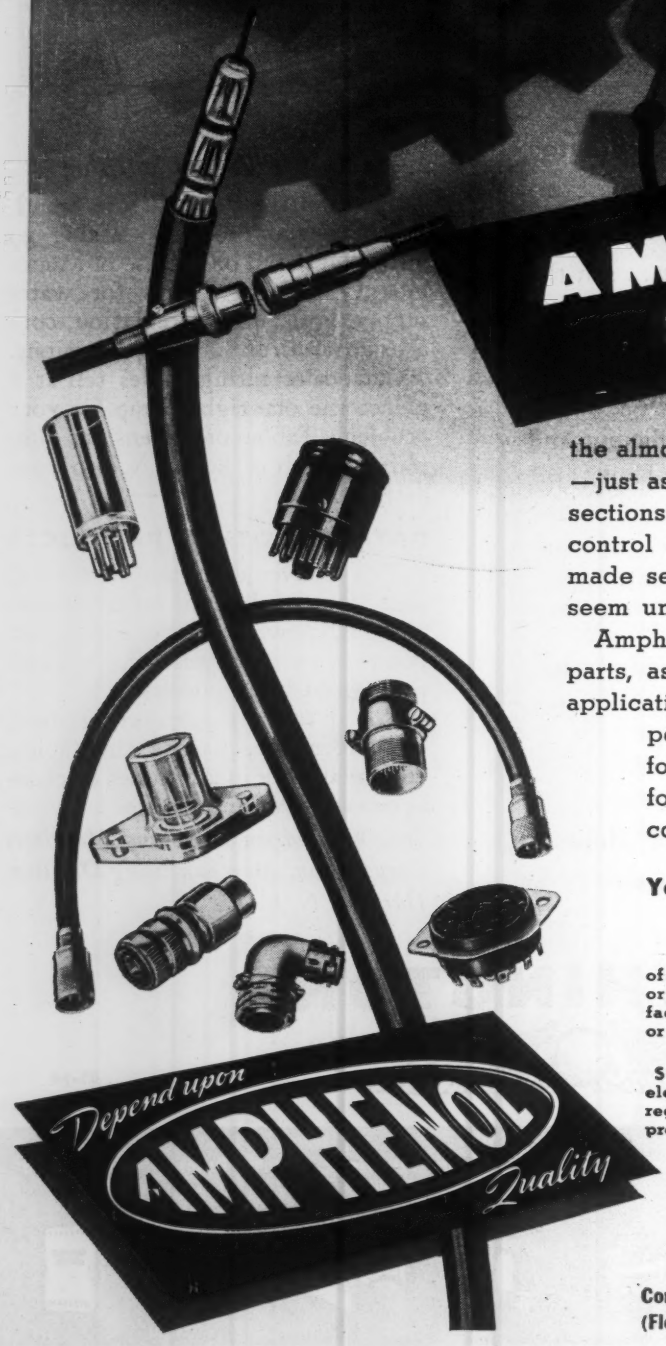
MONOBLOC Pump and Motor a Simple Balanced Unit



AMPHENOL
Supplies the Link

Linking electronic controls to power sources and to the almost human machines of modern industry is Amphenol's job —just as linking together the complex circuits of bombing plane sections or radar units was our war assignment. Vacuum tube control of manufacturing and processing operations already has made sensational progress . . . Future possibilities of electronics seem unbelievable.

Amphenol's precision connectors, fittings, and other electrical parts, assure functional dependability for all types of electronic applications. Amphenol engineers have a rich background of experience in designing and adapting the right components for electronic needs. For detailed technical information ask for the special Amphenol Catalog of radio and electric components.



You Will Be Using These Important Industrial Applications of Electronic Principles

CONTROL of operating conditions or quantity in manufacturing, processing or production.

MEASUREMENT of time, conductivity, color, etc.,—also analysis of light, noise, etc.

HEATING, dielectric or inductive for drying, sterilization, melting, hardening, etc.

STANDARDIZING electrical currents and regulating quantity or processes to standards.

SAFETY, to indicate hazards to personnel and equipment and to warn of dangerous conditions.

MISCELLANEOUS, unlimited uses with devices for weighing, counting and many types of inspection.

AMERICAN PHENOLIC CORPORATION
Chicago 50, Illinois
In Canada • Amphenol Limited • Toronto

Connectors (A-N, U.H.F., British) • Cable Assemblies • Conduit (Flexible) • Fittings • Cable • Radio Parts • Plastic Products

Investigate THIS *New* SHAFT SEAL!

The JOHN CRANE Bellows Shaft Seal is giving excellent and trouble-free service on all types of shaft sealing applications, such as found on the following:

Turbine Pumps • Speed Reducers • Refrigeration Compressors • Rotary Pumps • Agitator Shafts • Centrifugal Pumps

This precision-built Shaft Seal automatically adjusts for washer wear and shaft end play. Eliminates stuffing box leakage, gland adjustment and shaft wear. Excellent for high speeds and high pressures.

The JOHN CRANE Bellows Shaft Seal can be furnished in various metals and synthetic rubber stocks in order to best suit different operating conditions. Made in two basic types: Type I (for limited diameter) and Type II (illustrated above) for limited length.

A Synthetic Rubber Bellows—tail seals on shaft. Head is flexible; adjusts automatically for washer wear or shaft end play.

B Protecting Ferrule—prevents flexible bellows from adhering to shaft; assures free movement.

C Sealing Washer—rotates with shaft; driven through metal parts; no torque on bellows.

D Sealing Faces—both carefully lapped at our factory to insure a perfect seal.

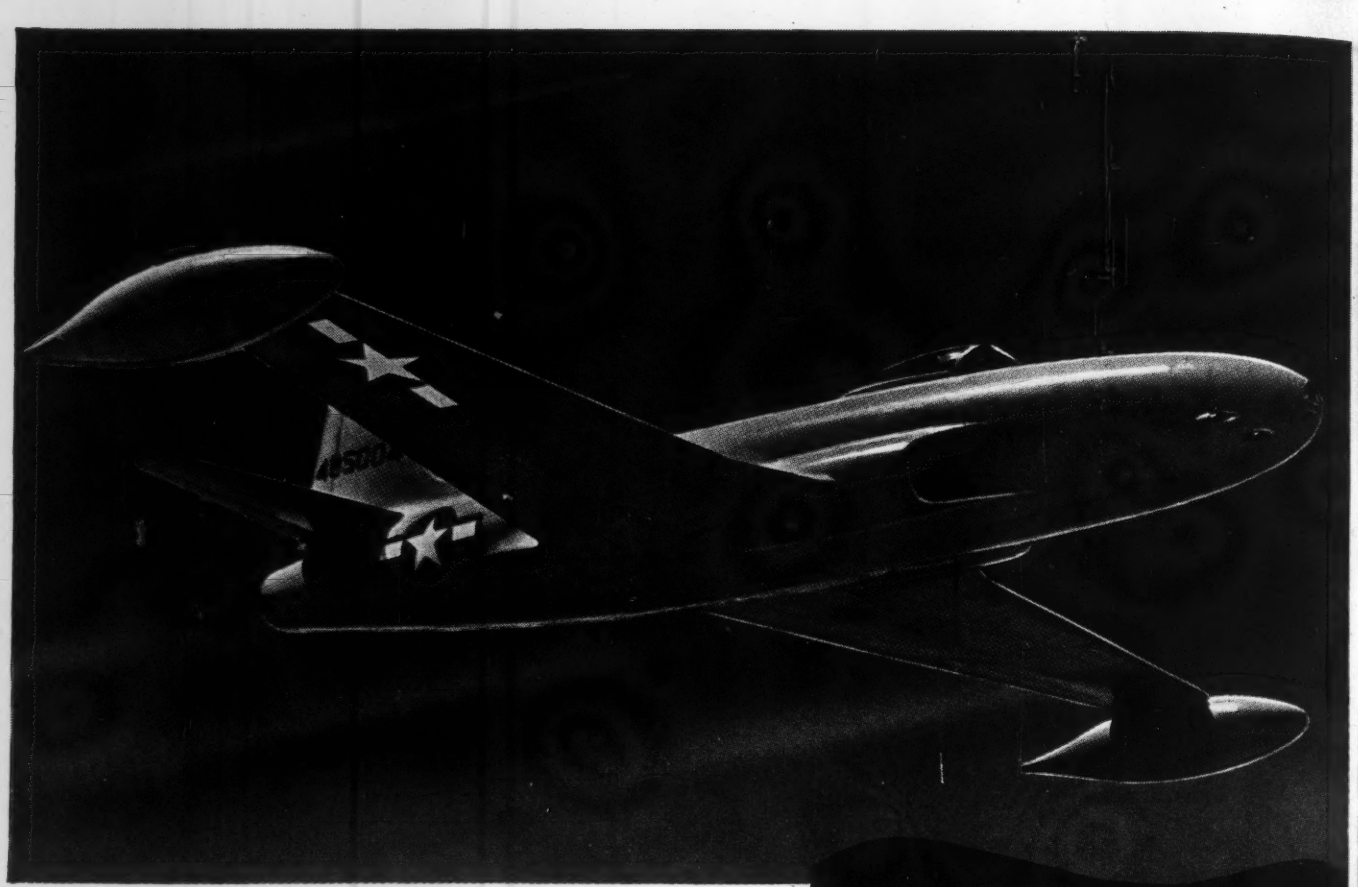
E Floating Seat—cushioned in synthetic rubber sealing ring, eliminating stress distortion of sealing faces.

Manufacturers and Design Engineers
Write for Bulletin!

Crane Packing Company

1825 CUYLER AVENUE
CHICAGO 13, ILLINOIS

Baltimore • Boston • Buffalo • Cleveland • Dallas • Detroit • Houston • Los Angeles • New Orleans • New York • Philadelphia • Pittsburgh • San Francisco • St. Louis • Tulsa



Blades for Breathing

Quantity Production Jet Turbine Blades Solved by Microcast Process

Flying higher and faster than ever before possible, jet propelled aircraft such as the Lockheed Shooting Star P-80 "breathe" vast quantities of air—supplied by turbine-driven compressors.

In designing blades for these turbines it was necessary to use high melting point, extremely hard alloys such as *Vitallium, capable of withstanding the tremendous force and heat of jet blasts. High melting point alloys being difficult and expensive to machine were a problem in quantity production. The answer—MICROCAST, the process of precision casting high melting point non-machineable alloys which has proven so successful in producing specialty blades by the millions for gasoline aircraft turbo-superchargers.

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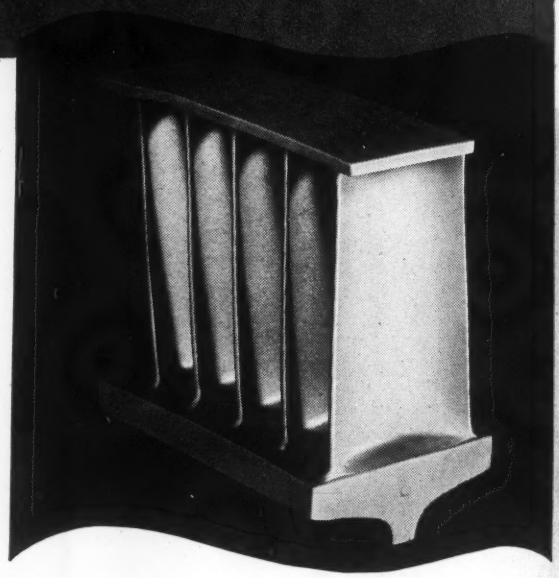


The MICROCAST Process is foremost in the precision casting of specialty blades for power development units. Engineers are finding that MICROCAST, by permitting the economical quantity production of high melting point alloy castings, has opened the way to many design improvements particularly where extreme resistance to wear and stress is required.

*VITALLIUM
A non-machineable alloy

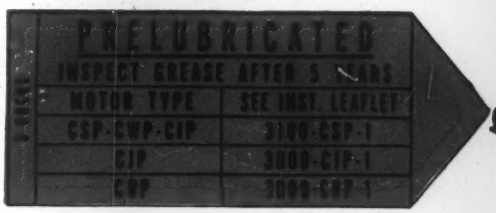
MICROCAST

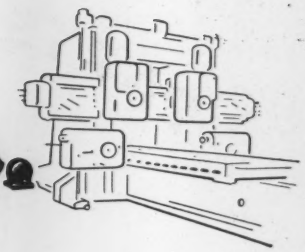
The precision process originated by Austenal Laboratories, Inc., for the production of castings of intricate design where accurate dimensions and surface smoothness are absolutely essential. Small castings produced by Microcast Process require little or no machining. Consider Microcast in your product plans.

AUSTENAL LABORATORIES, INC.

224 East 39th Street, New York 16, New York
5932 South Wentworth Avenue, Chicago 21, Illinois

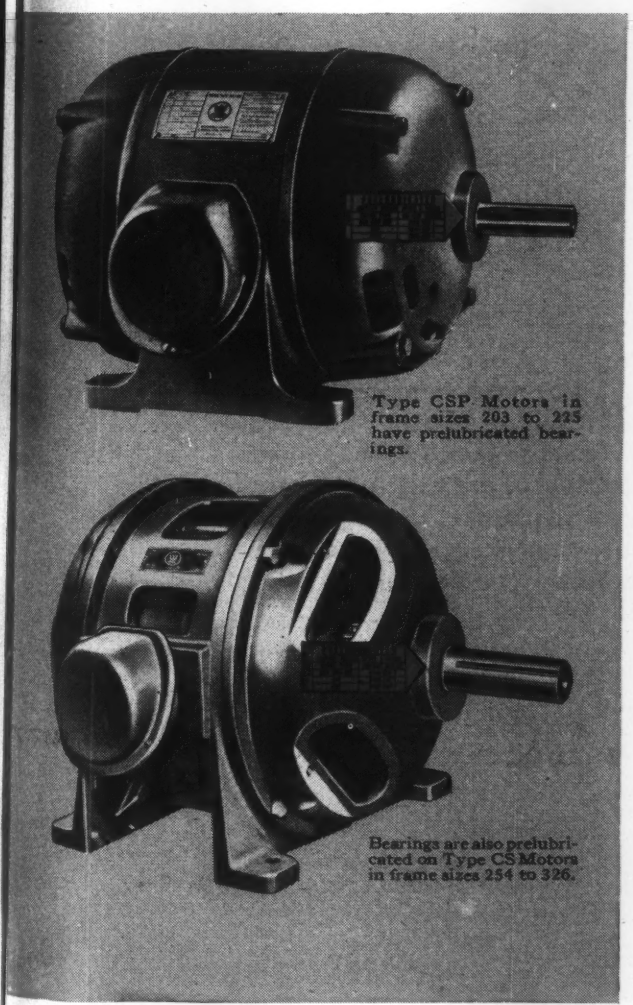
with this*





you won't need this

for 5 years or more



Type CSP Motors in frame sizes 203 to 225 have prelubricated bearings.

Bearings are also prelubricated on Type CS Motors in frame sizes 254 to 326.

It's easier than ever to keep squirrel-cage motors in top running condition—now that they need no lubrication for 5 years or more. That means practically no maintenance whatever.

In sizes up to 15 hp, Types CSP and CS, frames 203 to 326, Westinghouse squirrel-cage motors now leave the factory with ball bearings prelubricated and sealed so they don't need even an inspection for 5 years or longer.

This factory prelubrication is good for 5 years or more of 24-hour-a-day operation, and it assures no overgreasing . . . no "skipped" bearings . . . no grease contamination . . . no grease seepage . . . no unreplaced pipe plugs. All these facts have been proved by on-the-job tests on machine tool applications and in busy textile mills. For further details, write for Bulletin B-3554 and Descriptive Bulletins 3100-CSP and 3100-1, to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21363

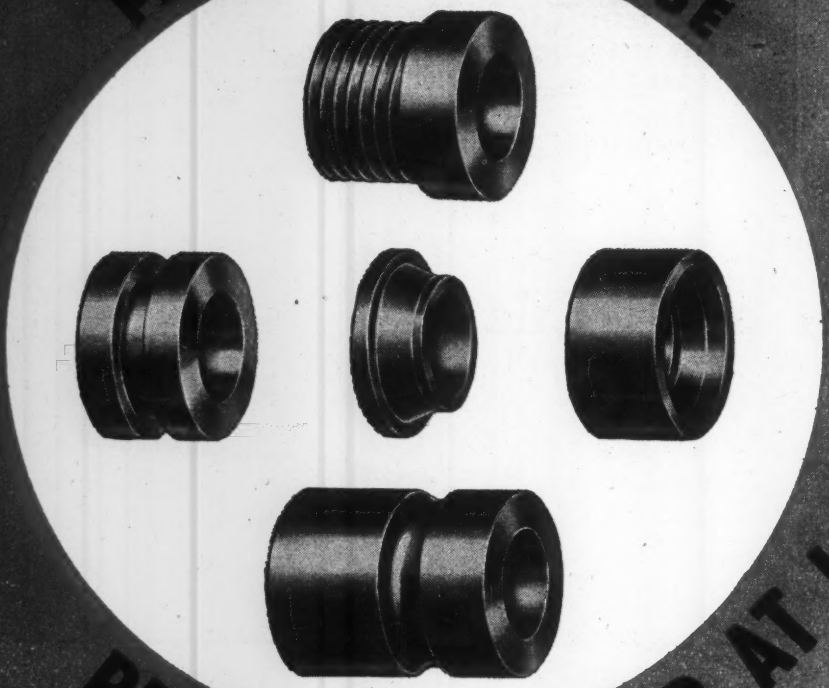
* Another Westinghouse "First"—the identification label for motors that you "Don't lubricate for 5 years or more".

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

SQUIRREL-CAGE MOTORS

PARTS LIKE THESE PRODUCED FASTER AT LOWER COST



BOOKLET OF COST SAVING DATA

Every designing engineer and production executive has use for the information contained in the 20-page bulletin "Rockrite Close Tolerance, Cold Reduced Seamless Tubing." Full explanation of the Rockrite process. Tables and charts explaining and comparing customary tube tolerances with the new tolerances obtainable in Rockrite Tubing. It's free — write for your copy today.

from Rockrite tubing

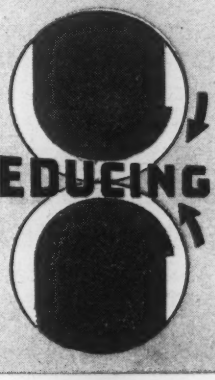
**The demand for the
greatest possible output per machine and per man
is imperative — and attainable
through the use of Rockrite tube stock
in machining ring shaped or cylindrical parts.
It may be your solution to
the urgent problem of how to meet
aggressive competition, rising costs, ceiling prices.**

**Rockrite tubing is sized by a new method to
entirely new and closer tolerances.
Saves valuable production time and
lengthens tool life. It permits
lighter, faster cuts —
as high as 117 S.F.M.
with high speed steels.
Greatly increased with
bonded carbide tools.
Makes practicable the wider use of
one-operation forming-tools.
Often no machining is necessary on
outside or inside surfaces.**

**Slow drilling or boring necessary with
bar stock or forgings,
is replaced by
fast reaming or broaching with Rockrite tubing.
Thus, the bottleneck operation of automatics
is avoided and
other stations made available for
other operations without decreasing rate of output.
Often two parts may be
machined in one cycle.**

**The unique Rockrite rolling process, combining
compression and extrusion
raises physicals of some steels
such as SAE X1020
without heat treatment.**

**Rockrite is available in
straight or tapered tubes
extra long pieces
bi-metal telescoped tubes.**



TUBE REDUCING CORPORATION
WALLINGTON
NEW JERSEY

Sealed — AGAINST WEAR AND TEAR

Spring freshets would like to drive logs and debris through a beaver's domain, and autumn's drought tries to steal his home away. So the beaver long ago turned engineer. He *seals* his dam against upsets—slaps sticks, leaves and mud into stout masonry.

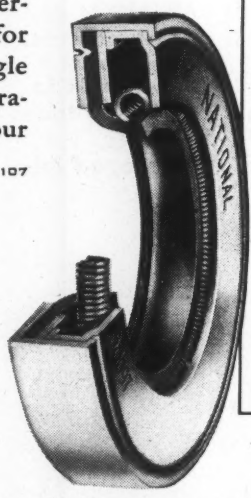
National Oil Seals work like beavers, at almost no cost, to keep lubricants *in* and hold dirt *out* of vital bearings and gears. Wherever shafts turn, in war machines or home industry, there's a job for Nationals. Built in the world's largest plants devoted to the single problem of oil retention, they can be "tailored" to fit any operation, large or small. There's a National engineer not far from your plant. Call him in.

1107

NATIONAL MOTOR BEARING CO., INC.

General Offices: Redwood City, Calif. • Plants: Redwood City, Calif., Van Wert, Ohio • Los Angeles, Calif. (Arrowhead Rubber Company)

NATIONAL
OIL AND FLUID SEALS



CALL IN A NATIONAL ENGINEER FOR RECOMMENDATIONS
No Obligation

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135 S. LaSalle St., Central 8663
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DETROIT
1015 Fisher Bldg., Trinity 16363
MILWAUKEE
1717 E. Kane Place, Lakeside 2838
NEW YORK CITY
122 E. 42nd St., Lexington 28260
PHILADELPHIA
401 N. Broad St., Bell-Walnut 6997
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2244 E. 37th St., Kimball 6384
REDWOOD CITY, CALIF.
Bdwy. and National, Rdwd. City 3400

WHEREVER SHAFTS MOVE, THERE'S A NATIONAL OIL SEAL TO RETAIN THE LUBRICANT

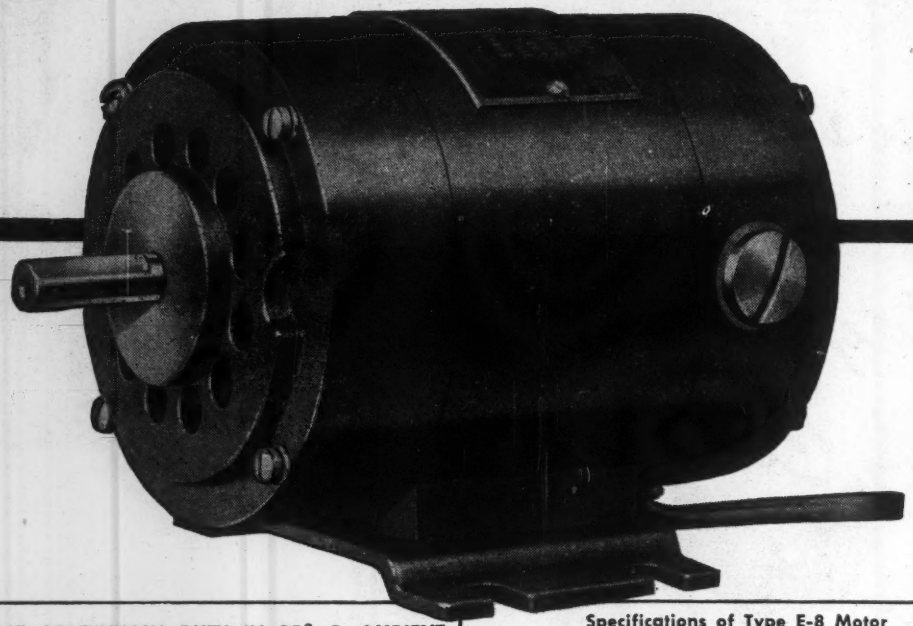
• Yes, sir — they've done some mighty tricky things with magnesium! . . . but that's no reason to shy away from it on your "every day" jobs. If it's lightweight, high strength and unusual stamina you're after, consider Magnesium Sand Castings. Superior engineers will be glad to help you use Magnesium Sand Castings to best advantage.

Literature on designing, machining, and finishing magnesium castings—on request.

Superior Magnesium Castings

DIVISION OF SUPERIOR BEARING BRONZE CO., INC. • 151 BANKER STREET • BROOKLYN 22, N. Y.

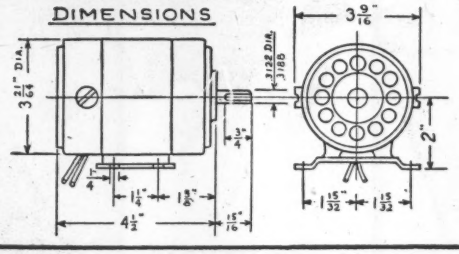
MAGNESIUM SAND & DIE CASTINGS TO MEET U. S. ARMY & NAVY SPECIFICATIONS



115 VOLT CONTINUOUS DUTY IN 25° C. AMBIENT					
Maximum H.P.	1/12	1/16	1/25	1/35	1/50
R.P.M.	7500	5800	3800	2800	1750
Amps Input	.8	.67	.46	.38	.32
Starting Torque in % of F. L. Torque	200 min.	200 min.	200 min.	200 min.	200 min.

Specifications of Type E-8 Motor

DIMENSIONS



Your new product will perform *better* and have *additional* sales appeal . . . with a dependable Oster motor

A modern, scientifically engineered motor, such as any one of many different sizes and styles made by Oster, is of prime importance in making your product perform satisfactorily.

The model E-8 Oster Motor illustrated above gives you the advantages of light weight, compactness, and dependable, trouble-free performance. Here are the details:

HOUSING — Die cast, open or totally enclosed.

FINISH — Black, baked enamel.

BEARINGS — Single or shielded ball bearings, or sleeve bearings.

BRUSHES — Furnished with metal graphite or electro graphite brushes of ample size to assure unusually long brush life. Phosphor bronze or beryllium copper brush springs.

WINDINGS — Available for operation on 12, 24 or 115 volts, in shunt, series, and split series types.

MOUNTINGS — Available for either base or flange mounting.

MODIFICATIONS — Motors can be furnished with special shaft extensions, finishes, leads, etc. Motors can also be furnished for operation in high ambient temperatures and high altitudes.

All ratings and data are approximate.

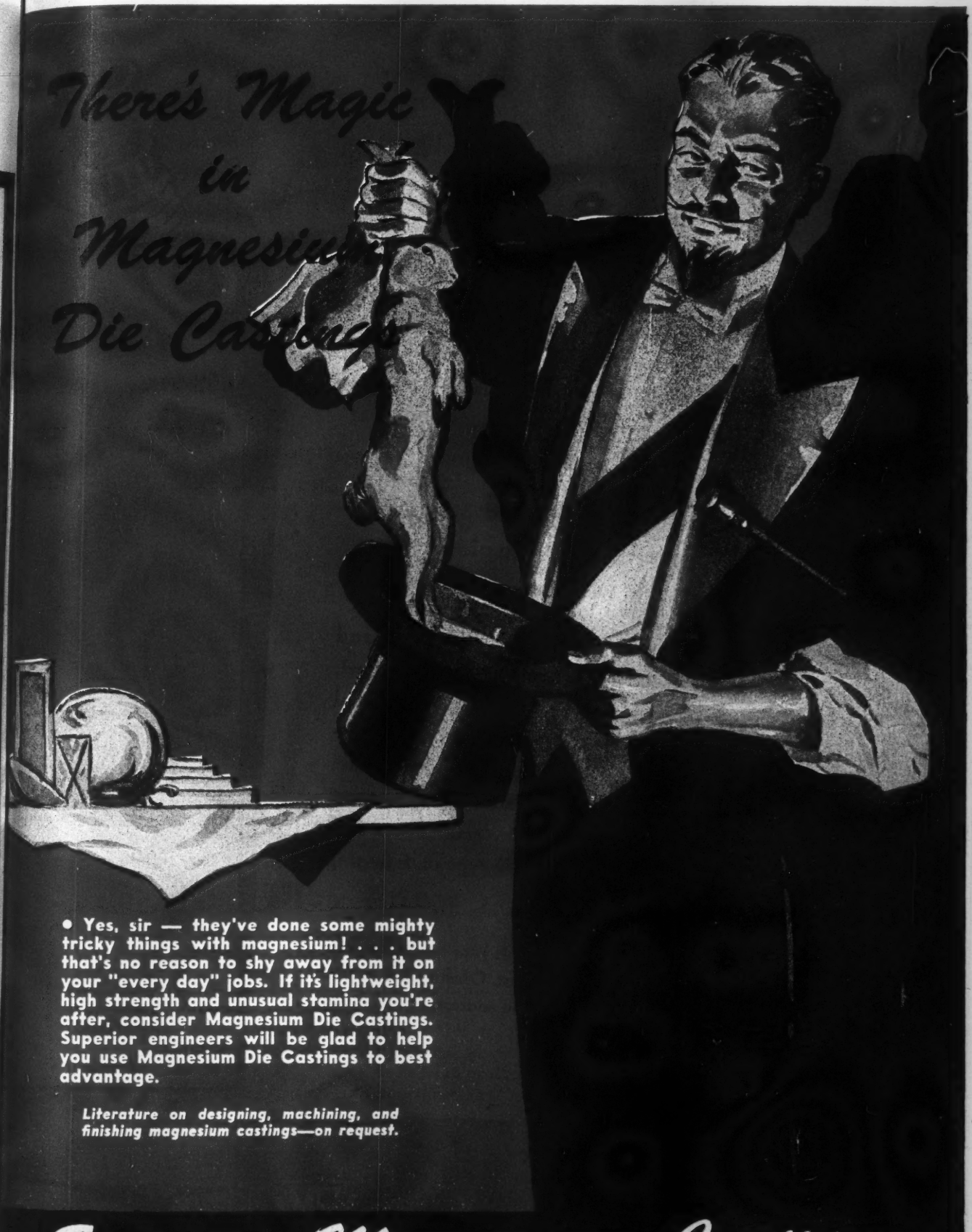
Let us help you fit this and other famous Oster Motors to your requirements.

Oster FRACTIONAL H.P. ELECTRIC MOTORS

John Oster Manufacturing Co.

DEPARTMENT M-29 • RACINE, WISCONSIN

M-29



• Yes, sir — they've done some mighty tricky things with magnesium! . . . but that's no reason to shy away from it on your "every day" jobs. If it's lightweight, high strength and unusual stamina you're after, consider Magnesium Die Castings. Superior engineers will be glad to help you use Magnesium Die Castings to best advantage.

Literature on designing, machining, and finishing magnesium castings—on request.

Superior Magnesium Castings

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MAGNESIUM SAND & DIE CASTINGS TO MEET U. S. ARMY & NAVY SPECIFICATIONS

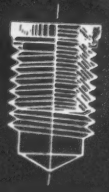
SOLVED

The Problem of Fastening in Light Metals

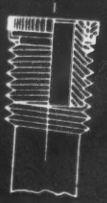
Postwar Designs call for light metals... a fact which immediately brings up the problem of an adequate means of fastening in these soft materials.

Rosán Locked-in Inserts and Studs have solved this problem completely for the designer and the manufacturer

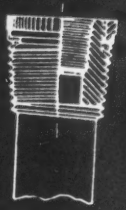
Rosán Locked-in Fastening units give soft metals, and plastic-impregnated woods, the fastening strength of steel. They cannot loosen or turn under vibration or any normal torques; and they can be easily replaced without disturbing the parent material. No more oversize replacements; no long drilling jobs, and a profitable and easy salvage of castings where threads have been damaged. There is a Rosán Locked-in Insert or Stud for every type of fastening problem.



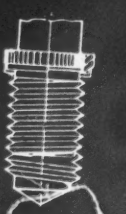
Standard Insert



Bushing Insert



Pipe Thread Seal



Standard Stud

Write for this free catalog and submit your fastening problems to our Engineering Department. Consultation is free. Please give your firm name, title and address when writing to Department 16-125.

ROSAN

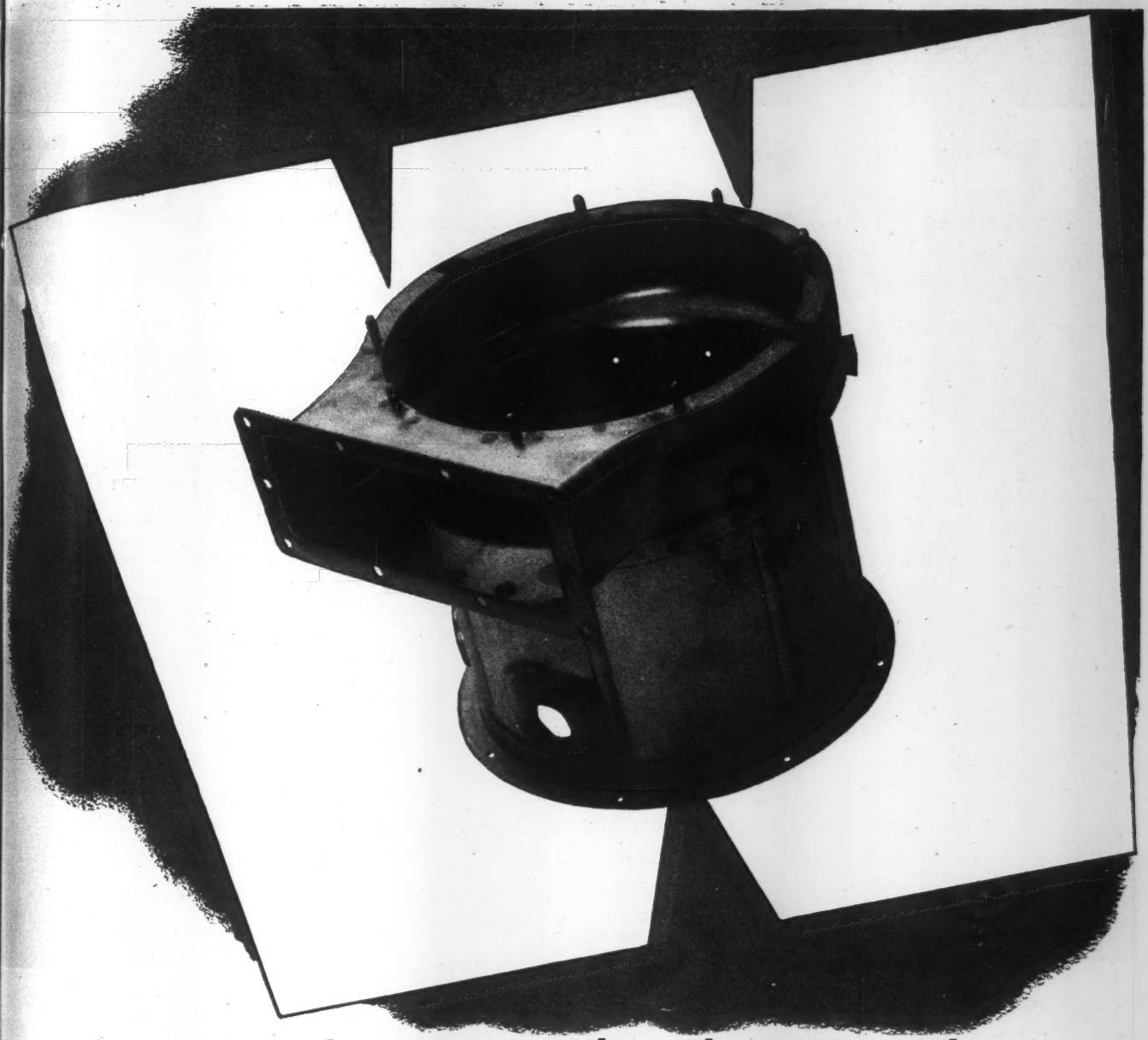
A Product of

BARDWELL & McALISTER, INC.

Box 1310 • Hollywood 28, Calif.

Original Developers and Manufacturers of Rosán Fastening Units

Rosán Fastening units are used extensively in the Pan-American Flying Clippers.



They Knew What They Wanted...

but it took PRESTEEL to find how to make it

Here is a casing for a B-29 Stratoheater, an outstanding wartime heating development. The designers furnished a rough drawing and from this meager data, Presteel engineers developed a case made from precision stampings that met all specifications.

This casing had to fit connections with the gasoline heating unit and leads already installed in the fusilage — had to fit perfectly to avoid all vibration. Weighing only 1-lb. 11-oz. the housing contained a unit strong enough with its fan to heat the whole cabin at sub-zero stratosphere temperatures—equivalent to heating a six-room house.

When you specify Presteel stampings they are fully guaranteed by the leading company using controlled press operations. Why not let Presteel handle *your* stamping problems?

WORCESTER PRESSED STEEL CO.

812 Barber Avenue, Worcester 6, Mass.

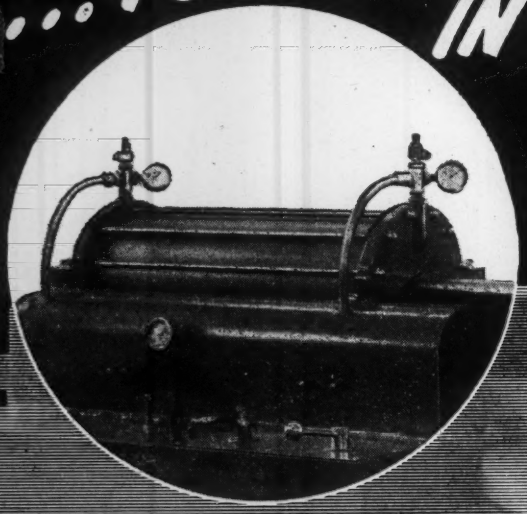
ALLOY STEELS AND OTHER METALS COLD FASHIONED SINCE 1883

Representatives in Alexandria Virginia, Buffalo, Canton Ohio, Chicago, Denver, Detroit, Fort Worth, Indianapolis, Los Angeles, New York, Philadelphia, Syracuse, Toronto

INDUSTRY SPECIFIES

T-J CYLINDERS

... FOR TOUGH JOBS IN POWER MOVEMENT

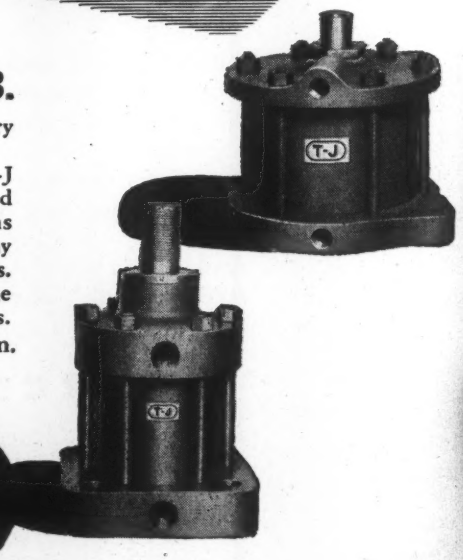


A T-J Cylinder has a vital job on this Pressure Contour Forming Machine! Used with various fixtures for producing contours in aircraft wings, fusilage, top body parts and similar structures.

FOR PUSH-PULL-LIFT JOBS...100 LB. OR 50,000 LB.

Today—more and more tough jobs in power movement throughout industry are geared to T-J Air and Hydraulic Cylinders!

Whether it's pushing, pulling, lifting, clamping or controlling... T-J Cylinders simplify the job and speed up production! Ideal for machines and equipment such as presses, hoists, shears, valves, brakes, hopper gates, ovens —or any place where efficient *controlled power movement* is needed. Many standard sizes and styles...both cushioned and non-cushioned types. Precision-manufactured to deliver smooth dependable power in every stroke —with utmost dependability and long life! Write for latest catalogs. The Tomkins-Johnson Company, 606 Mechanic Street, Jackson, Michigan.



FOR TOUGH JOBS SPECIFY T-J

TOMKINS-JOHNSON

RIVITORS...AIR AND HYDRAULIC CYLINDERS...CUTTERS...CLINCHORS

HYDRAULIC *Pressure Boosters*

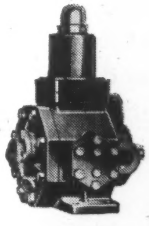
3,000 LBS. P.S.I.

This patented RACINE development will produce the needed higher pressures in your oil hydraulic circuits. It is available in several ratios, as high as 7 to 1. Maximum delivered pressure 3000 lbs. Maximum output 5 G.P.M. A 5 to 1 Unit will automatically convert 25 gallons of oil at 500 lbs. P.S.I. into 5 gallons at 2500 lbs. P.S.I. Ideal for handling peak loads in many pressing and closing operations.

The RACINE Pressure Booster is very compact. Size 10⅛" x 8⅛" x 18". It may be placed anywhere in the circuit. No special foundation needed. Standard low pressure valves may be used. For maximum benefits and Volume Variation use the booster with RACINE "Variable Volume" Oil Hydraulic Pumps. Ask for our Bulletin No. 1404 and also give us an outline of your hydraulic problem.

RACINE
Booster Features

- ★ Use any pump—yet develop extra pressure without increase in motor power.
- ★ Compact, simple—No special foundation or supports required.
- ★ Freedom from repairs—No gears to wear or complicated mechanism requiring adjustment.
- ★ Use regular low pressure valves—No special equipment to buy.

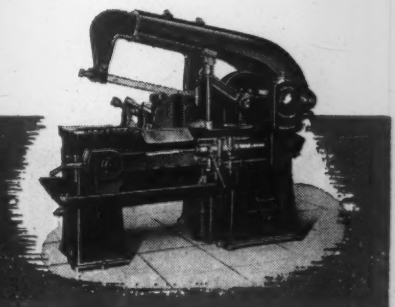


"Variable Volume" Oil Hydraulic Pumps

RACINE "Variable Volume" Pumps are adaptable to a wide variety of uses. They provide smooth, oil-cushioned operation for your products. Available in three sizes, 12, 20 and 30 G.P.M., operating at pressures up to 1000 lbs. P.S.I. This equipment assures maximum flexibility at low operating cost. Fully explained in our Catalog P-10-C. Get your copy today. RACINE TOOL AND MACHINE COMPANY, 1773 State Street, Racine, Wis.

THE PRODUCTION SAWS OF MODERN INDUSTRY

For the high speed cutting of any metal from soft aluminum tubing to hard alloy steel. A full line of machines for general purpose and high production metal cutting work. Capacities 6" x 6" to 20" x 20". Fully explained in our Catalog No. 12.



STANDARD FOR QUALITY AND PRECISION
RACINE
RACINE TOOL and MACHINE CO.

RACINE

Service without fanfares

A Statement of Fact for Buyers of Precision Gears

We manufacture precision gears to customers' specifications. The gears have a high finish, and the tolerances are as close—or better—as the specifications indicate. Our production equipment, comprising the finest, modern machine tools, occupies a space in excess of 250,000 square feet. Thus our facilities are ample to meet practically any demands for the mass-production of precision gears. A highly efficient inter-departmental follow-up system enables us to steadily maintain an unusually high percentage of delivery promises. Finally, our engineers almost always manage to devise methods and equipment for the production of *special* gears, if the means for doing the job are technically feasible.

In short, once we undertake to do a job for you, we do it well. *Period!*

All of these facts are taken for granted by our good friends and customers of many years' standing. They may be of interest, however, to other actual or potential buyers of custom-cut gears. In the face of mounting reconversion problems, said facts will *definitely* interest anyone looking for a source of supply so satisfactory, that he will be able to devote all of his efforts to his main job: The *uninterrupted* production, distribution and sale of his own products.

LET'S GET TOGETHER NOW!

PERKINS MAKES

Helical Gears

Bevel Gears, Ratchets,

Worm Gears,

Spiral Gears, Spur Gears,

Ground Thread Worms

PERKINS *custom-cut* GEARS

PERKINS MACHINE & GEAR COMPANY, SPRINGFIELD 2, MASS.

Here is a hard-to-make part for a fuel injection pump. Making it in *any* quantity calls for a complete understanding of the problem, and full appreciation of the close tolerances required — to say nothing of a very real ability to use modern skills, methods, machines and tools.

That Nichols has been able to produce this part in volume (at prices far below competition) proves that Nichols not only possesses the facilities *but also knows how to integrate them to your advantage.*

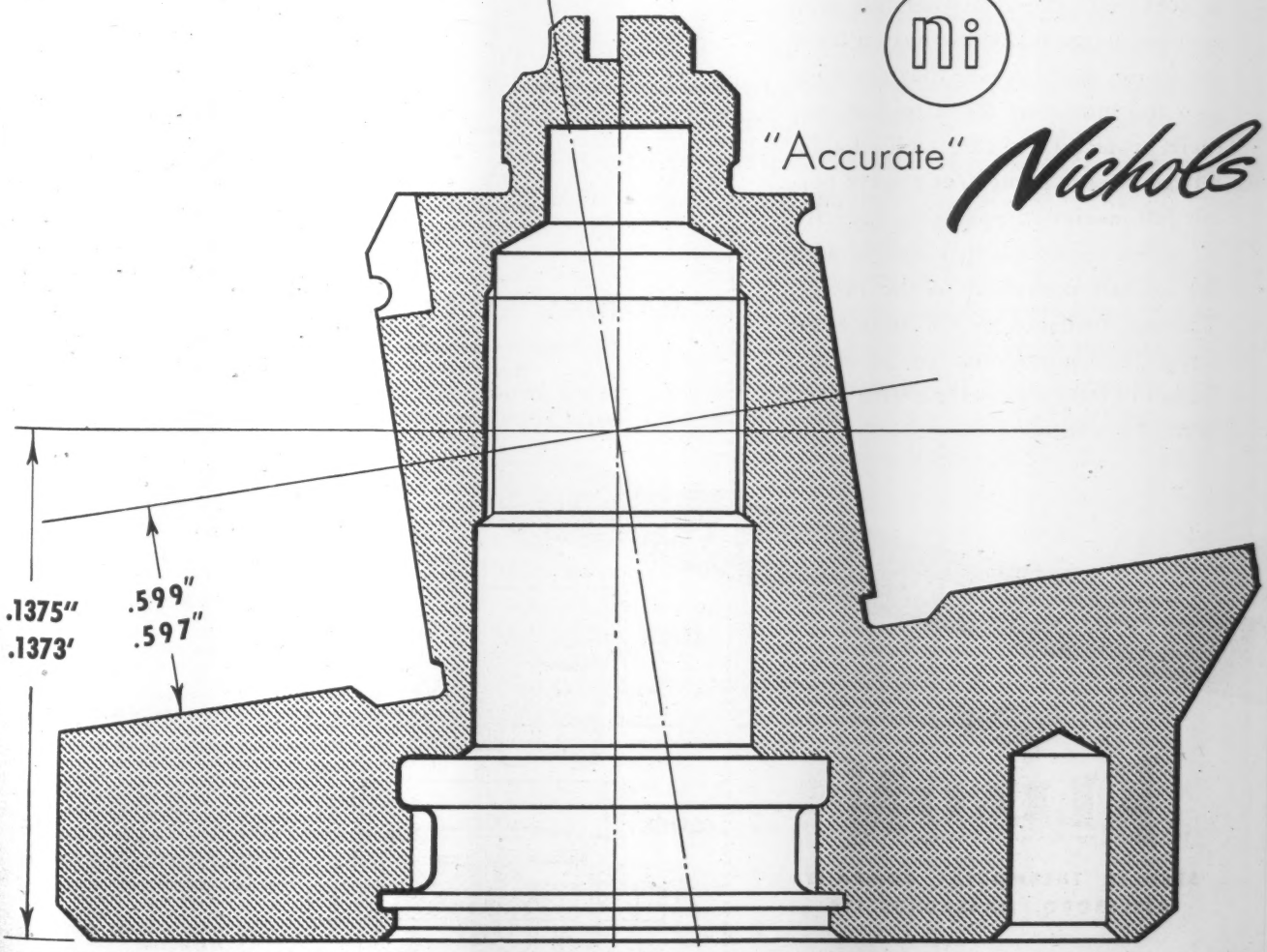
Because the *cost* of difficult, extremely accurate parts or assemblies is always important, Nichols "Mass Precision" methods should interest *you.* Send for a copy of our "Mass Precision" booklet. It shows some of the jobs we have done for others . . . suggests what we can do for you.

W. H. NICHOLS & SONS, 48 Woerd Avenue, Waltham, Mass.

Another Slant ON MASS PRECISION BY

ni

"Accurate" *Nichols*



PRECISION ENGINEERING AND MANUFACTURING FACILITIES FOR MASS PRODUCTION

KLIXON *Motor Protectors*

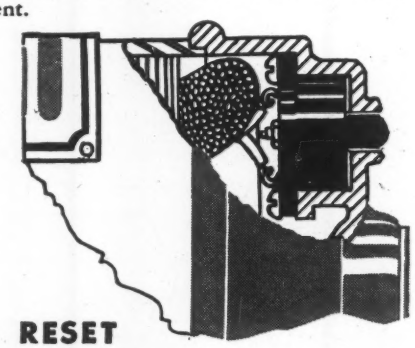
Overcome the Hazards of Motor Burnouts . . .

Motor burnouts cost money. They mean repairs, replacements, production delays. Yet you can prevent your motors from overheating and burning out by buying motors with built-in Klixon Protectors.

Low in cost, Klixon Protectors cut motors "off" the line whenever they become dangerously overheated from any cause. And because they are built into the motor by the manufacturer, their protection is sure and reliable. Klixon Motor Protectors always permit full maximum operating capacity . . . never unnecessarily interfere with the normal operation of the motor. They are available for A.C. motors all sizes; D.C. motors up to 30 volts. Bulletin PR-112 gives the entire story. Write for a copy.

AUTOMATIC RESET

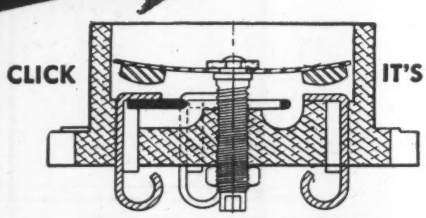
Automatic reset types are recommended for all applications except those where unexpected starting may cause injury. Examples of automatic reset applications are refrigeration, air conditioning, air compressors, blowers, and unattended automatically controlled equipment.



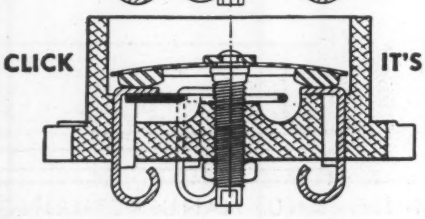
MANUAL RESET

The manual reset type should be used for those applications where hazard is involved in an unexpected starting of the motor, such as washing machines, hand tools, power saws, machine tools, irons, etc.

Here's How It Works . . .



Should a motor become overheated and dangerously hot, the Klixon Protector snaps the power "off" preventing the motor from burning out.



When the motor cools to safety, the Klixon Protector snaps the power "on" automatically if the automatic reset is specified . . . *or when the reset button is pushed when manual type is specified.*

KLIXON

SPENCER THERMOSTAT COMPANY
ATTLEBORO, MASSACHUSETTS

SOMETHING NEW AND BETTER IN ELECTRICAL INSULATION

RECENT laboratory accomplishments have made possible new grades of Formica laminated plastics that have many qualities that were not before available in combination in any one material.

The development of new materials—glass cloth and glass mat fibre bases, and Melamine resins—have made this possible.

Among these new grades are varieties that stand more heat and more arcing than laminated material would take before. Others provide greater mechanical strength. And some are more efficient insulators of high frequency currents, approaching ceramics in that regard, but providing strength and vibration resistance for parts that must perform important structural functions.

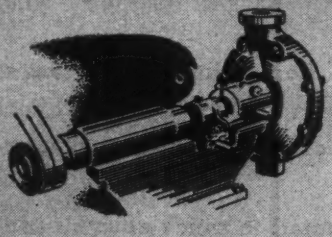
As all of these grades are free from cellulose they resist fungus growth. Water absorption is low and does not affect either stability of dimensions or stability of electrical characteristics.

All grades are machinable—adapted to quick efficient production methods. Engineering details on request.

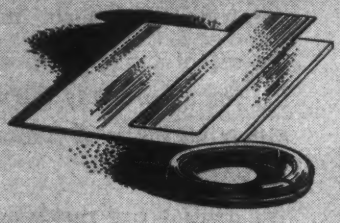
THE FORMICA INSULATION COMPANY
4648 Spring Grove Avenue • Cincinnati 32, Ohio

For the Tough Jobs use H

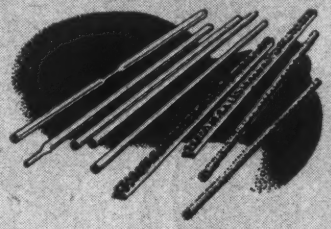
Properties of HAYNES STELLITE Alloys	Average Tensile Strength, psi	Average Hardness, Rockwell	Melting Point, Deg. F	Can be Forged	Can be Rolled
HAYNES STELLITE Cobalt-Base Alloys					
1	47,000	C54	2,282	No	No
6 Cast	105,000	C40	2,327	Yes	Yes
Rolled	130,000	C40 to C46			
12	76,000	C48	2,306	No	No
Star J-Metal	65,000	C61	2,318	No	No
98M2	63,000	C62	2,250	No	No
HASTELLOY Nickel-Base Alloys					
B Cast	80,000	B96	2,440	Yes	Yes
Rolled	135,000	B98			
C Cast	76,000	B93	2,350	No	Yes
Rolled	120,000	B90			
D Cast	38,000	C53	2,040	No	No
HAYSTELLITE Tungsten-Base Alloys	—	Between 9 and 10 Moh's Scale	—	No	No
HASCROME Iron-Base Rod	40,000	C40-50 after peening	—	Yes	Yes



Castings . . . A wide range of castings can be supplied in:
HAYNES STELLITE Alloys 6, Star J-Metal, 98M2, 93
HASTELLOY Alloys B, C, D
HAYSTELLITE Tungsten-Base Alloys



Rolled Forms . . . Sheets and plates are made from:
HAYNES STELLITE Alloy 6
HASTELLOY Alloys B, C
Hot-rolled bars are supplied in:
HASTELLOY Alloy B



Welding Rods . . . for applying a wear- and corrosion-resistant alloy coating to other metals:
HAYNES STELLITE Alloys 1, 6, 12
HASTELLOY Alloys B, C, D
HAYSTELLITE Alloys
HASCROME Rod

HAYNES STELLITE Alloys

Resistance to Corrosion		
Oxidation at High Temp.	Sulphuric Acid	Hydrochloric Acid
Excellent	Fair	Fair
Excellent	Fair	Fair
Excellent	Fair	Fair
Excellent	Fair	Fair
Excellent	Fair	Fair
Fair	Good	Excellent
Excellent	Good	Good
Fair	Excellent	Fair
—	—	—
Fair	—	—

Available in a wide range of properties and forms to resist wear, corrosion, and heat . . .

HAYNES STELLITE alloys are specially made to meet the requirements of industry's most difficult applications. They are hard, tough, and heat-resistant and are used for those parts of equipment and machines that are most subject to wear and corrosion. The chart at the left describes some of these alloys and their significant properties. Sketched below are some of the forms in which they can be furnished.

For further information, write for the booklet, "Properties of HAYNES STELLITE Alloys."

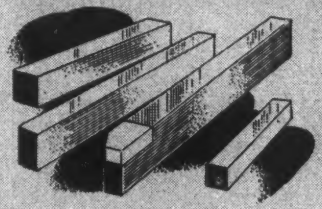
HAYNES STELLITE COMPANY

Unit of Union Carbide and Carbon Corporation

UCC

General Office and Works, Kokomo, Ind.

Chicago—Cleveland—Detroit—Houston—Los Angeles—New York—San Francisco—Tulsa



Metal-Cutting Tools . . . made from HAYNES STELLITE Alloys, known for their red hardness. These tools take heavy cuts at high speeds and coarse feeds—with long life between grinds:

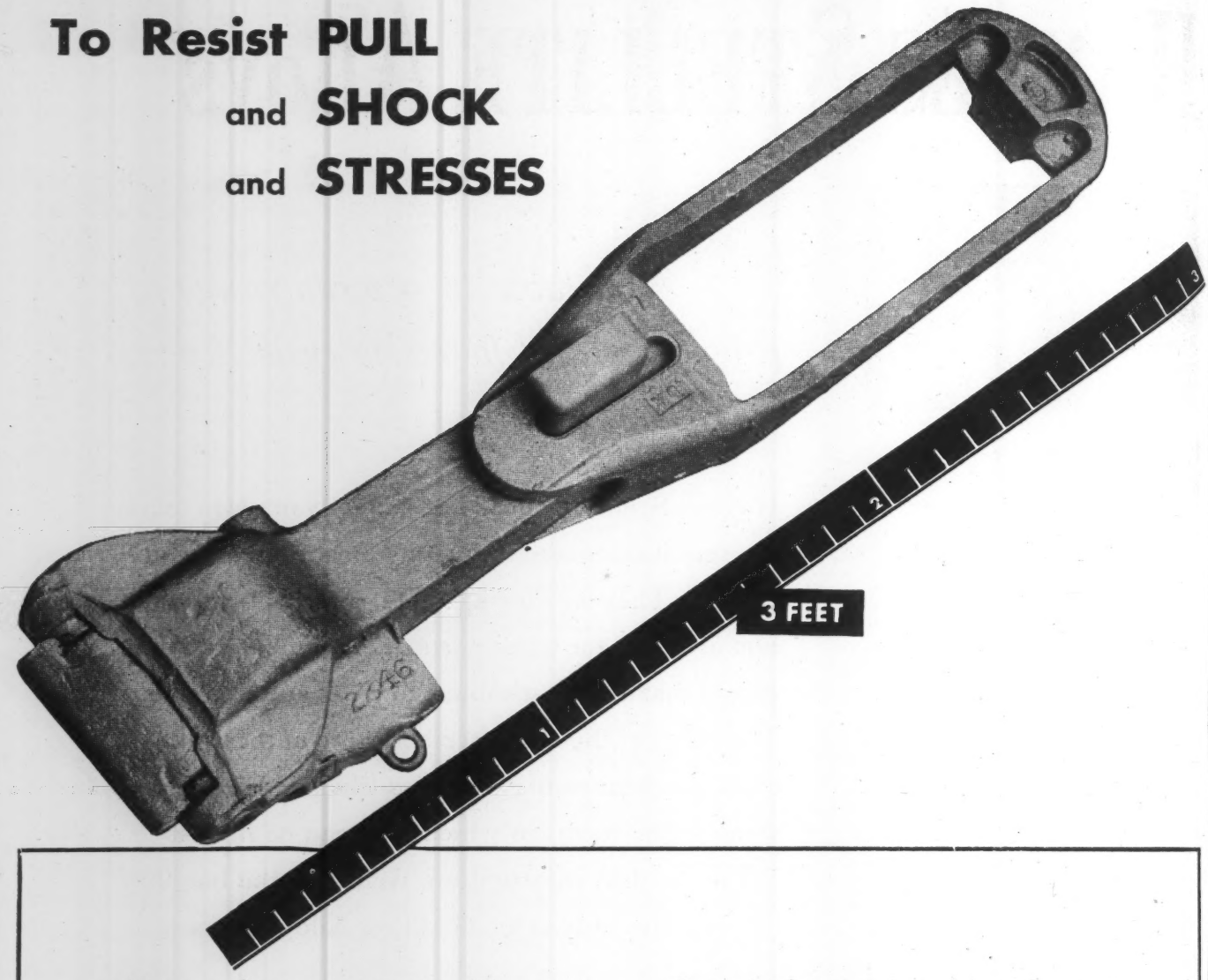
HAYNES STELLITE Star J-Metal
HAYNES STELLITE Alloy 98M2

HAYNES STELLITE TRADE-MARK

HAYNES STELLITE . . . HASTELLOY . . . HAYSTELLITE . . . HASCROME are registered trade-marks of Haynes Stellite Company.

BUY AND HOLD UNITED STATES VICTORY BONDS AND STAMPS

To Resist PULL and SHOCK and STRESSES



• Your safety—even your life—may depend upon the performance of the modern cast steel railway coupler and yoke.

It must have the tensile strength to stand the pull of the heaviest trains at high speeds, plus the impact resistance to stand the shocks and stress of sudden stops and starts.

And it is economical to produce, because the casting process is the simplest method of turning out complicated shapes in steel, with selected mechanical properties prescribed in advance.

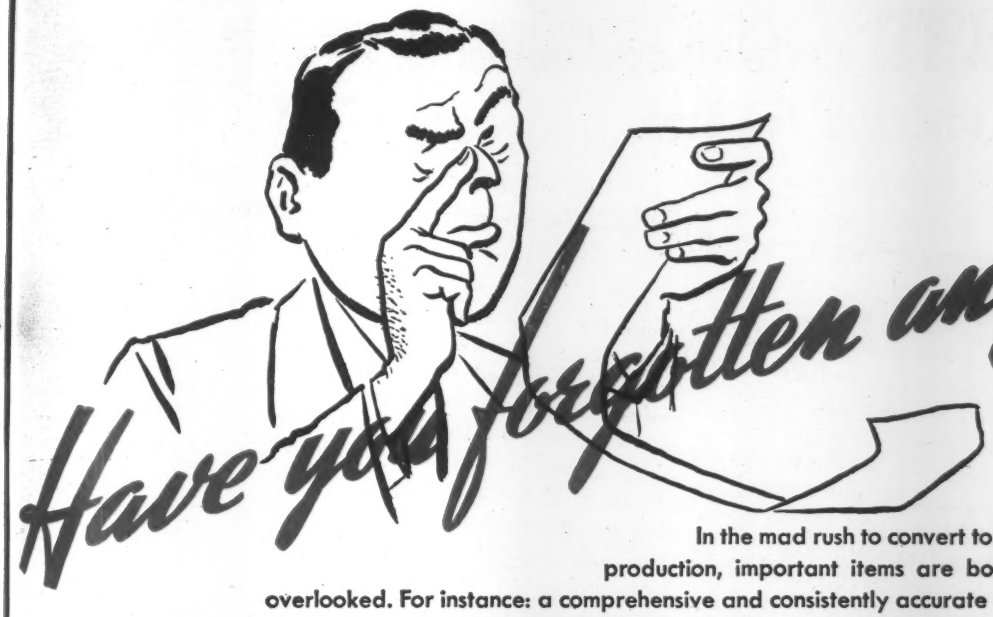
Organized research and broad experience enable your steel foundryman to supply you with steel formed to the desired shape, with the properties, or combination of properties, your work demands.

Railroads, and a hundred other industries, have proved for you the versatility and the economy of properly designed steel castings, and their complete dependability in service.

Discuss it with your foundryman, or write to Steel Founders' Society, 920 Midland Bldg., Cleveland, Ohio.

MODERNIZE AND IMPROVE YOUR PRODUCT WITH

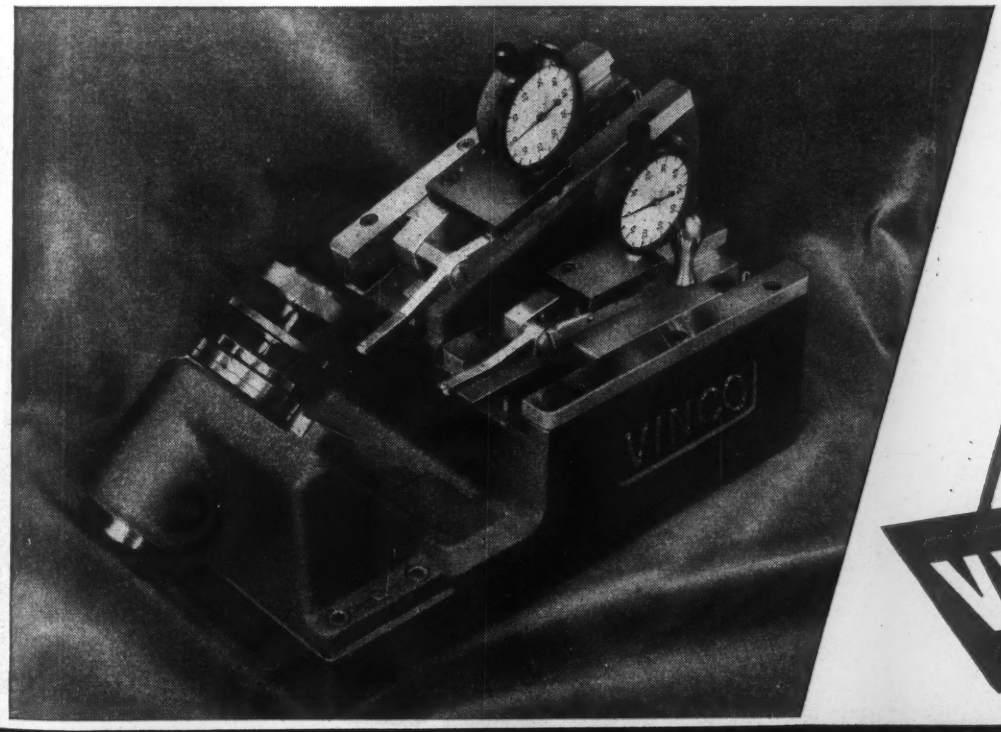
STEEL CASTINGS

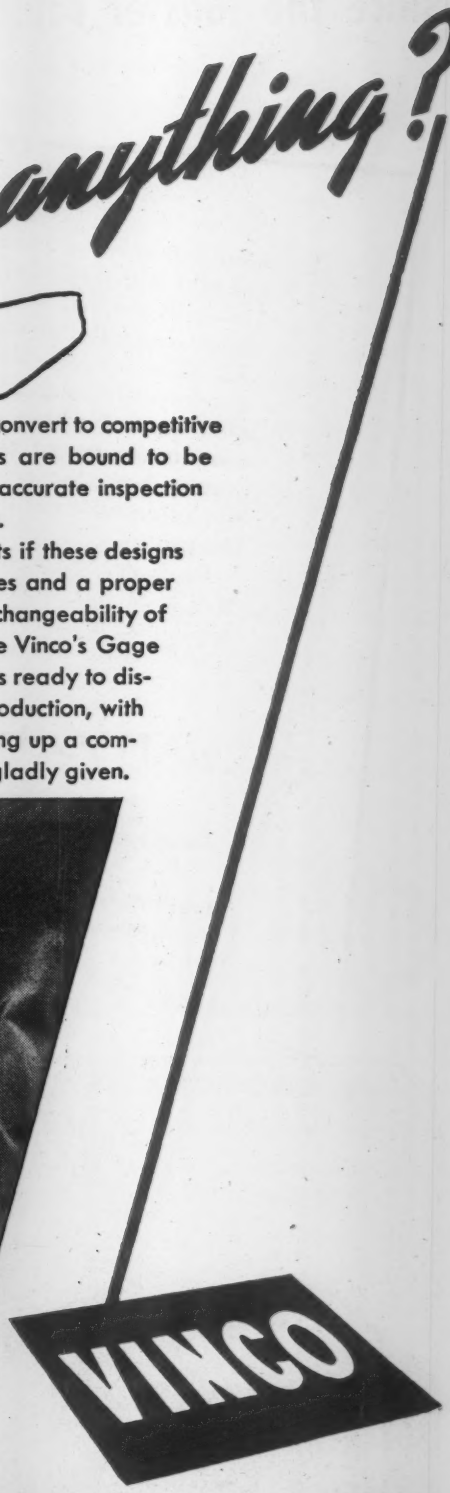


Have you forgotten anything?

In the mad rush to convert to competitive production, important items are bound to be overlooked. For instance: a comprehensive and consistently accurate inspection control of related parts, vitally essential to future quality production.

It is too apparent for comment that future designs will depend on precision parts if these designs are to function correctly. It is equally apparent that the selection of reliable gages and a proper over-all gaging method will play a large part in the correct assembly and interchangeability of parts. One way to insure this is to join the ever-increasing ranks of those who use Vinco's Gage Engineering Service when planning new production schedules. At all times, Vinco is ready to discuss the complete subject of gaging, together with the attendant problem of production, with your engineering staff. Our assistance to your engineers in establishing and setting up a complete and comprehensive gaging policy, suited to your individual needs, will be gladly given.





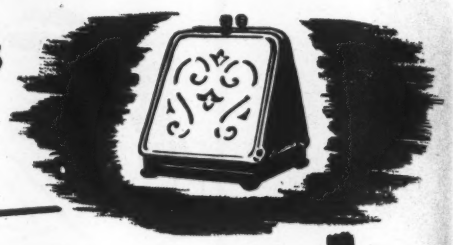
MILLIONTHS OF AN INCH FOR SALE BY VINCO

REG. U. S. PAT. OFF.

VINCO CORPORATION, 8875 SCHAEFER HIGHWAY, DETROIT 27, MICHIGAN; SALES OFFICES, NEW YORK, CHICAGO, CLEVELAND

Semi-Automatic Hydraulic Spline and Gear Grinder • Optical Master Inspection Dividing Head • Involute Checker • Angle Tangent to Radius Dresser • Index Plates • Precision Vises • Sine Bars • Straight-side Spline, Serration Spline, Involute Spline and Helical Spline Plug and Ring Gages • Thread Plugs, Rings and Setting Plug Gages • Spur and Helical Master Gears • Munition Gages • Propeller Shaft and Hub Gages • Built-up and Special Gages • Gear Rolling Inspection Fixtures • Indexing Fixtures • Hydraulic Power Control, Utilization and Distribution Units • Engineering, Design and Development • Precision Production Parts.

PROTECTING electrical appliances since the toaster replaced the fork



Doing the unusual is daily routine to the electrical appliance industry. Unusual, too, are the requirements called for in the plating equipment that gives modern electrical conveniences their long life and lasting eye-appeal. Finishes must resist or conduct current in varying degrees, must withstand severe thermal shock, and often take the beating of careless use.

In developing such finishes, H-VW-M has worked closely with appliance manufacturers since the home toaster was a novelty.

Even the old toasting fork, which the streamlined "pop-up" has replaced, was plated with H-VW-M equipment. Today, we stand ready to work with *all* industries in the planning and layout of new plating and finishing departments, and to offer technical counsel on the operation and equipment of existing plants. Write us now to find how our century and a quarter background can be applied to your present or anticipated requirements.

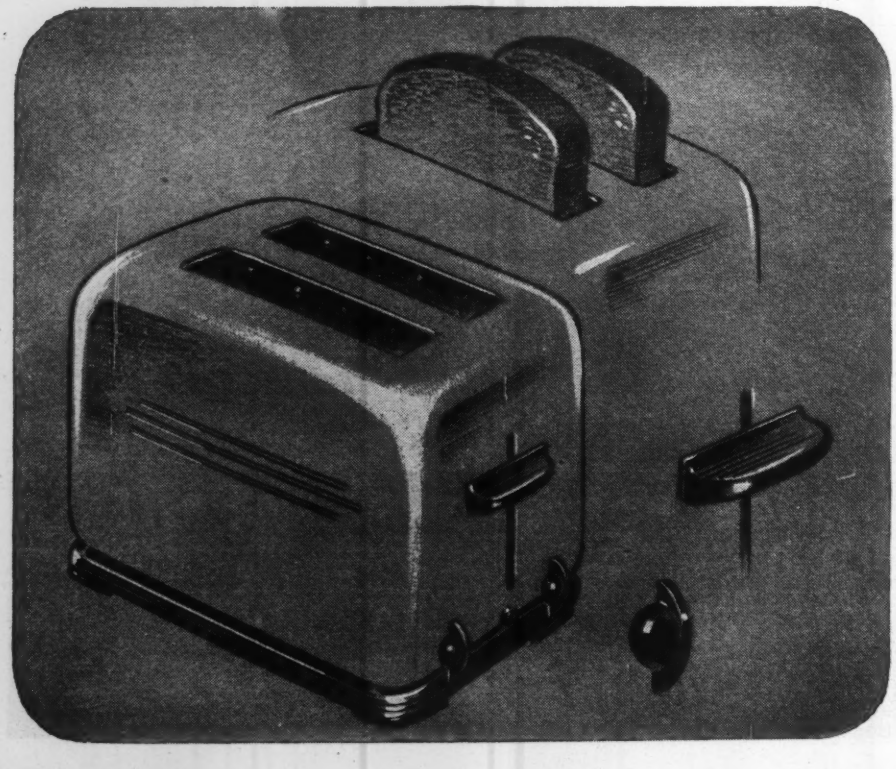
HANSON-VAN WINKLE-MUNNING CO.

MATAWAN, NEW JERSEY

Manufacturers of a complete line of electroplating and polishing equipment and supplies

Plants: Matawan, New Jersey • Anderson, Indiana

Sales Offices: Anderson • Chicago • Cleveland • Detroit • Elkhart • Matawan Milwaukee • New Haven • New York • Philadelphia • Pittsburgh Springfield (Mass.) • Syracuse



ABRASIVES
ANODES
BRUSHES
BUFFS
BURNISHING BARRELS
CENTRIFUGAL DRYERS
CLEANERS
COMPOSITIONS
CONVEYORS *(Semi-Automatic)*
CONVEYORS *(Full Automatic)*
DIPPING BASKETS
GENERATORS
MICROSCOPES *(Electroplater's)*
PLATING BARRELS
RECTIFIERS
RHEOSTATS *(Tank)*
TANKS
WHEELS *(Polishing)*
WRAP-RAX

7499

UNBRAKO

Reg. U. S. Pat. Off.

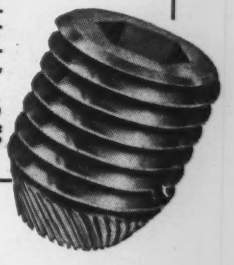
What more COULD YOU *possibly* WISH IN A SOCKET CAP SCREW?

Of course it is made of high-grade alloy steel—*of course* it is specially heat-treated. But the "Unbrako" Socket Cap Screw is outstanding in "extra features", too. Accurate as a seven-day clock—strong as a couple of elephants. Smooth and neat as a fine piece of jewelry. And the knurled head makes a firm grip a *cinch*—even for oily, greasy fingers. It can be screwed into place faster . . . saves you time and trouble . . . Really—*what more could you possibly wish?*

AND THE "UNBRAKO" SOCKET SET SCREW . . .

Here again are outstanding quality features of strength, accuracy, hardness—plus the fact that it's a Self-Locker, because those knurls "dig-in" and hold tighter than a bulldog, can't be shaken loose!

Both screws come in sizes from No. 0 to 1-1/2" in diameter, full range of lengths. Want more information? Write for our "Unbrako" Catalog.



STANDARD PRESSED STEEL CO.

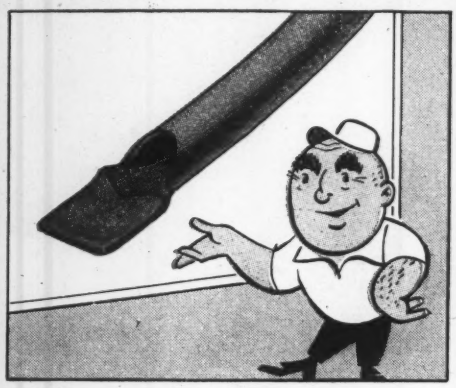
JENKINTOWN, PENNA. BOX 102

BOSTON • CHICAGO • DETROIT • INDIANAPOLIS • ST. LOUIS • SAN FRANCISCO

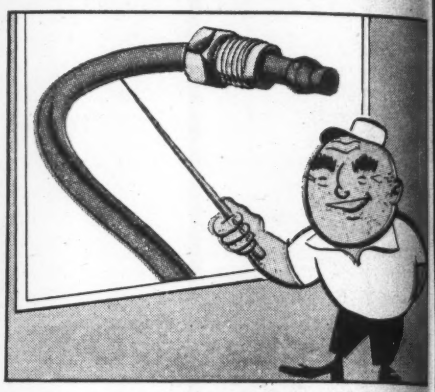
Knurling of Socket Screws originated with "Unbrako" years ago.

SEE HOW EASILY
BUNDYWELD IS FABRICATED

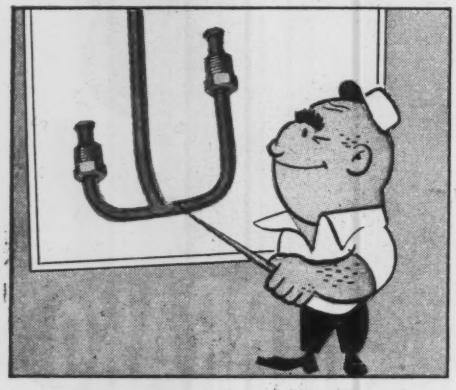
1 THIS SMALL PIECE of Bundyweld is double upset, flanged, expanded and notched.



2 A NOTCHED and flattened end is simple with Bundyweld Steel Tubing.

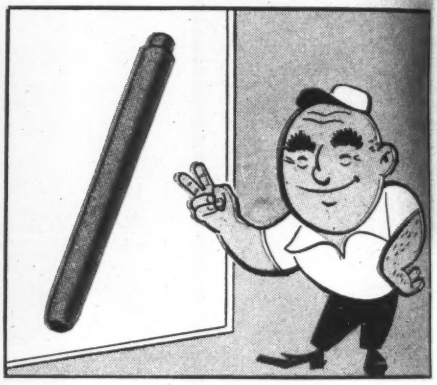


3 SHARP BENDS are easily made without flattening. Note the use of compression fittings.



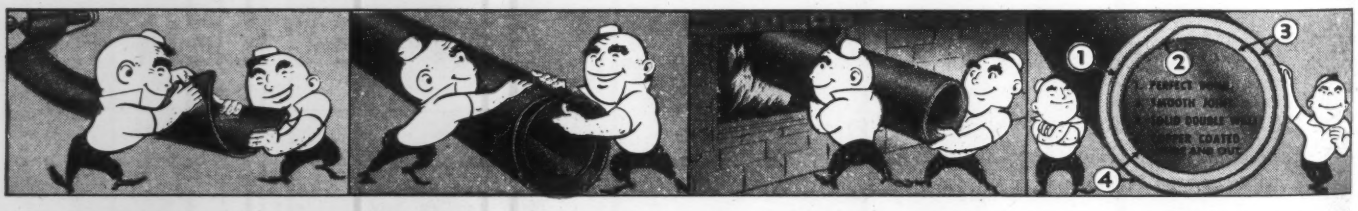
4 THIS PART shows how Bundyweld may be saddle flanged, pierced and silver soldered together for a right angle connection.

5 SMALL TUBES take the double flare as readily as the larger sizes. This part fabricated from 3/16" O.D. Bundyweld.



6 TWO SCREW MACHINE operations . . . a sharply cut shoulder at one end and shaping for ball seat at the other end.

AN UNUSUAL MANUFACTURING PROCESS



1 Bundyweld Tubing is made by a process entirely different from that used in making other tubing. A single strip of copper-coated S.A.E. 1010 steel is continuously rolled twice laterally . . .

2 . . . into tubular form. Walls of uniform thickness and concentricity are assured by the use of close tolerance cold rolled strip. This double rolled strip passes through a furnace where the . . .

3 . . . copper coating fuses and alloys with the double steel walls. After brazing and cooling, it becomes a solid double wall steel tube, copper brazed throughout 360° of wall contact . . .

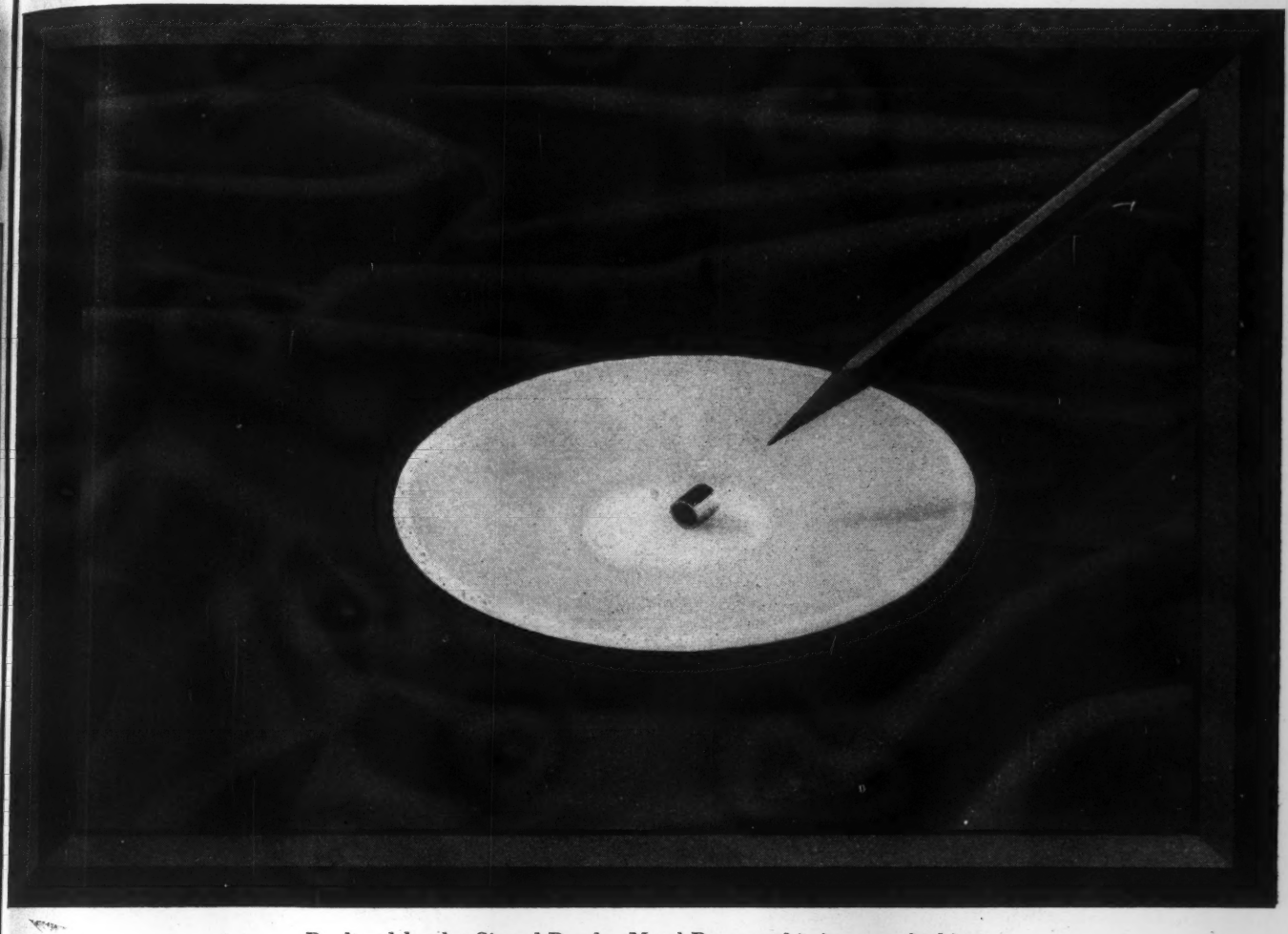
4 . . . copper coated inside and out, free from scale, closely held to dimensions. Hard or annealed in standard sizes up to 5/8" O.D. Special sizes cold drawn. Also in Monel and nickel.

BUNDY TUBING

ENGINEERED TO YOUR EXPECTATIONS

BUNDY TUBING DISTRIBUTORS AND REPRESENTATIVES:

Pacific Metals Co., Ltd. 3100 19th St. San Francisco 10, Calif.	Standard Tube Sales Corp. 1 Admiral Ave. Maspeth, N.Y.C., N.Y.	Lapham-Hickey Co. 3333 W. 47th Place Chicago 32, Illinois	Rutan & Co. 112 S. 16th St. Phila. 2, Pa.	Eagle Metals Co. 3628 E. Marginal Way Seattle 4, Wash.	Alloy Metal Sales Ltd. 861 Bay St. Toronto 5, Canada



Produced by the *Sinteel* Powder Metal Process, this innocent-looking part is *A VITAL COMPONENT OF THE FABULOUS VT FUZE.*

When Little Parts Pose Big Problems

Excerpt from a letter of the Applied Physics Laboratory, Washington, D. C. to Dr. Paul Schwarzkopf, our Director of Research.

. . . . "We think that you should know that your firm produced the most difficult class of sintered nickel cups from the standpoint of close limits . . . .

To meet the threat of the Japanese suicide bombers it was necessary to have the safety devices in these particular fuzes operate within very narrow time limits.

Had it not been for the superlative efforts of your company both as to quality and quantity we might not have been able to supply the Navy with the material which kept the fleet operating off Okinawa, to name but one instance which might be cited . . . ."

If you use parts let us look at them
Write, phone or wire.

American Electro Metal Corporation

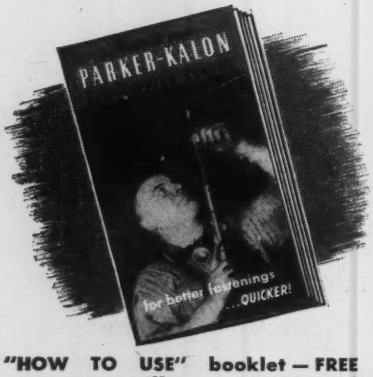
POWDER METALLURGY SINTEEL FOR MASS PRECISION

YONKERS 2, NEW YORK • • • Offices in Chicago, Dayton and Detroit

The man who looks at Fastenings

--and finds missing profits for you!

--the P-K Assembly Engineer



"HOW TO USE" booklet — FREE on request—will get you acquainted with P-K Self-tapping Screws and other Fastening Devices—if you are not yet ready to see a P-K Assembly Engineer. Ask for Booklet No. 480.

With profits diminishing in the squeeze between fixed selling prices and higher labor costs, every production department is on the spot to produce savings in the only way left — by short cuts in operations to eliminate every unnecessary work-hour.

If your job is assembly, the P-K Assembly Engineer can help you find plenty of missing profits that now are wasted in needlessly high costs.

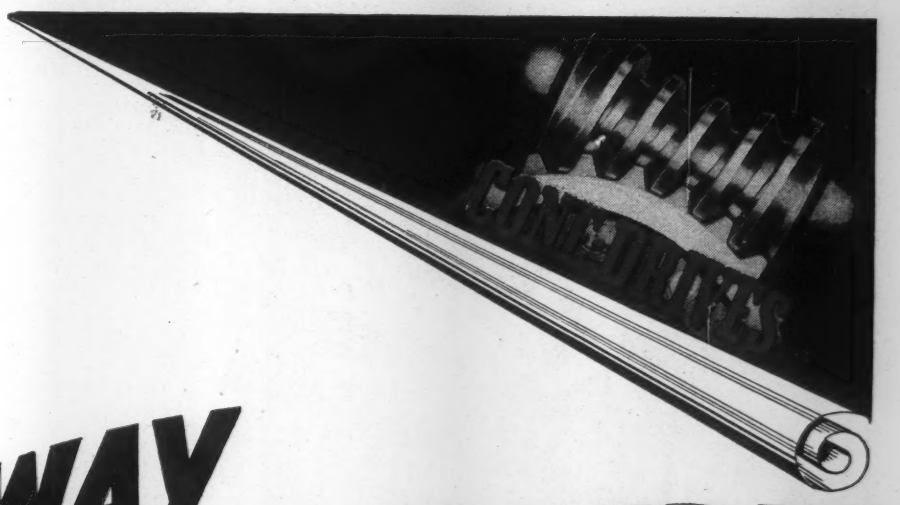
He may make a brief study in your assembly department and show you where operations like tapping, nut-running, riveting, or inserts in plastic can be eliminated. Or, when desired, he will put your assembly through a complete fastening survey in the P-K Laboratory.

For example, a P-K Assembly Engineer showed one manufacturer of gasoline hose nozzles how to make an assembly time saving of 80% by using P-K Screws instead of rivets! Savings in work-hours of 30% to 50% are common.

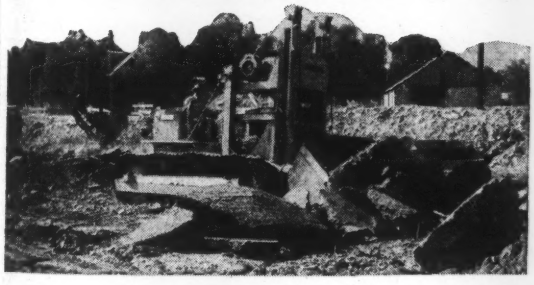
The P-K Assembly Engineer will call at your request, without obligation. You'll find his advice unbiased, because P-K makes *all* types of Self-tapping Screws. If you prefer, mail in assembly details for recommendation. Parker-Kalon Corp., 208 Varick St., New York 14, N. Y.

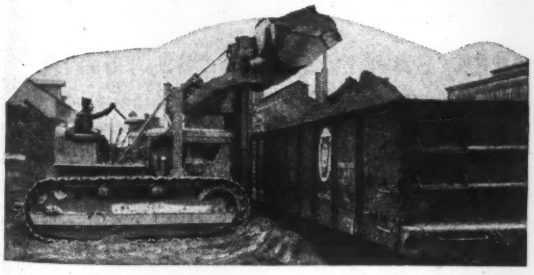
PARKER-KALON P-K SELF-TAPPING SCREWS

FOR EVERY METAL AND PLASTIC ASSEMBLY



there is AN EASY WAY TO LICK GEAR FAILURES





A few of the CONE-DRIVE operated "Traxcavators" at work.

If you have a job that's tough on right angle reduction gearing, there is a quick solution to your problem. Trackson Company had a problem like that. Their Model T-7 "Traxcavator" has to lift a 2½ cu. yard load some 10 feet to dumping position, through gearing operating through a 22:1 ratio on an eight inch center distance. When pilot model tests indicated a stronger gearing was needed, they substituted CONE-DRIVES.

Their Gear Troubles Disappeared

The reason is simple: CONE-DRIVE gearing has vastly greater contact area per tooth and also gives you more teeth in contact. The result is vastly lower unit-loading in lbs. per square inch and the ability to handle several times the load of other gearing of the same center distance and ratio.

In addition, if you wish, you can actually reduce gear size and still handle greater loads than with larger conventional gears. For an equal load capacity, CONE-DRIVES are only ⅔ the size, weigh only ⅓ as much.

We will be glad to send you literature on CONE-DRIVES pertinent to your products. Ask for it on your Company letterhead, today.

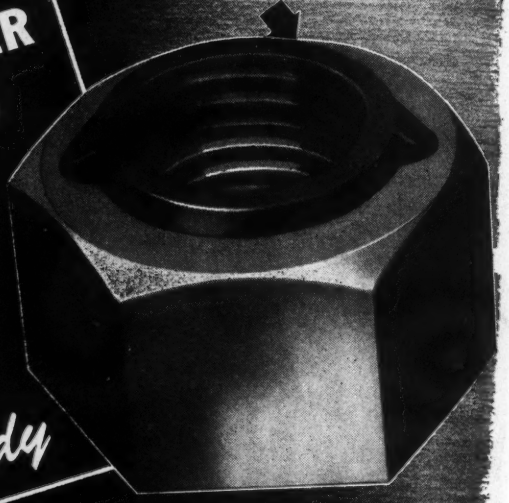
CONE DRIVE

CONE-DRIVE DIVISION **MICHIGAN TOOL COMPANY**
7171 E. McNichols Road, Detroit 12, U.S.A.

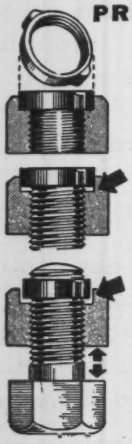
NUT CARRIES BOLT STRESS • OVAL STEEL COLLAR DOES THE LOCKING

Replace CASTELLATED NUTS AND OTHER TYPES OF BOLT FASTENERS with Security LOCKNUTS

Safe • Economical • Handy



HOW ISOLATION LOCKING PRINCIPLE WORKS!



Security is a patented combination of ordinary nut and oval steel collar with ears, fabricated into unit by press fit of oval collar into counterbore in crown of nut.

Threads in collar are misphased so that bolt pushes collar away from *bottom* of counterbore distance of ¼ to ½ thread before engaging.

Bolt passing through oval collar forces collar into *round*, isolating it from *sides* of counterbore also. Collar is now completely isolated from nut and is tightly locked to bolt.

Nut bears entire load, leaving collar free of load stress. Nut is kept from turning by ears of collar, which is locked tightly on bolt.

RE-USE WITHOUT SELECTIVE FITTING!

Because Security's oval, spring steel collar is unusually *RESILIENT*, Security Locknut can be used and *re-used* time and again on any bolt of like size without loss of locking power, *regardless* of maximum or minimum thread diameter tolerance. No matching! Just pick up the nut and apply it with ordinary wrench on any bolt of like size and *it stays put until you take it off!*

Safe No cotter key to forget or wear through . . . No bolt tension required. Locking power *not* affected by temperature or presence of lubricants . . . No ragged projections to snag flesh or clothing . . . Vibration *can't* shake Security loose!

Economical No holes to drill . . . No extra parts to handle or store . . . No maintenance expense—can be *reused* time and again *without selective fitting* on *any* bolt of like size and regardless of thread diameter tolerance or normal wear.

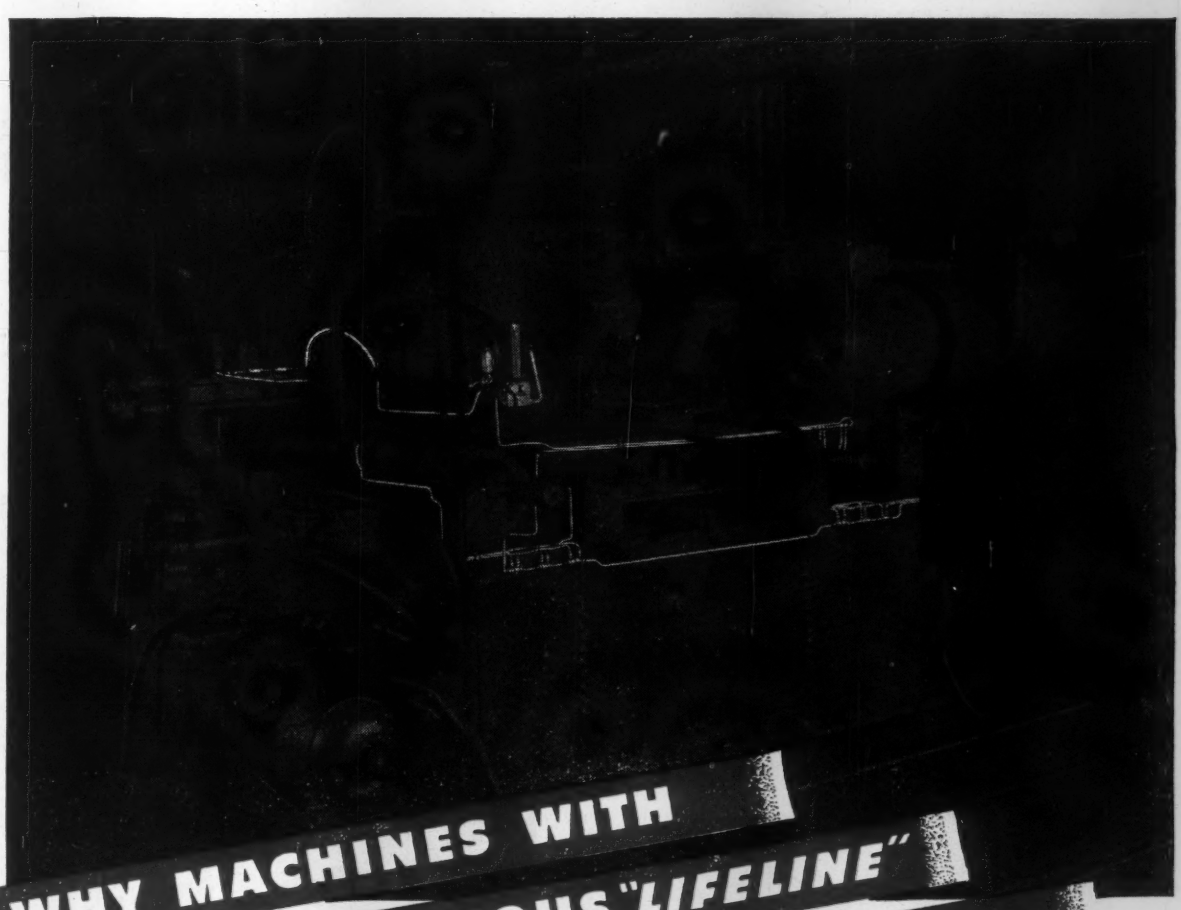
Handy No fixed positions of adjustment . . . No special tools needed to install or remove . . . No extra parts to worry about!

SEND FOR FREE SAMPLE, PRICES, DATA

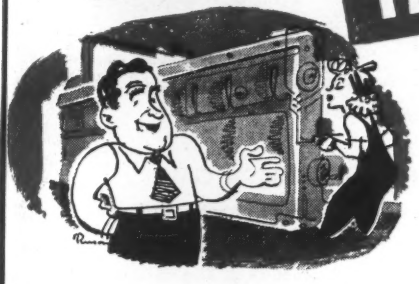
You are invited to *prove* to yourself at *our* expense the advantages Security Locknuts have over all other types of bolt fasteners. Send today for free testing samples and put them to work on your toughest assignment. Now made in National Course, National Fine, in sizes, as follows: ½ - ⅝ - ¾ - ⅞ - 1.

SECURITY LOCKNUT CORP., Dept. 1205 Chicago 5, Illinois
A SUBSIDIARY OF C. G. CONN LTD., ELKHART, INDIANA

Security LOCKNUTS



WHY MACHINES WITH THIS FAMOUS "LIFELINE" LIVE LONGER



When you design this "lifeline" of metal arteries into your machines, every vital part gets the lifeblood of *unfailing* lubrication.

It's the famous Alemite Centralized System of Lubrication, and it makes machines live longer by preventing the "dirty work" of neglect and human error. The system handles oil *or* grease, and can be operated manually or automatically. It is available in four types, which can be designed into practically any machine.

So "foolproof" are these Alemite Systems that new and inexperienced help can be quickly taught how to operate them.

Each bearing, no matter how inaccessible, gets a measured quantity of oil or grease.

And the machine goes right on operating while it's getting a "transfusion" from a central point!

This means a big saving in time as well as machines. That's why plant owners are installing Alemite Centralized Systems on present equipment. So it's logical to include these "lifelines" in the machines you are now designing.

Results are amazing. This one is typical: A huge roto printing press with 500 bearings is now positively lubricated *while in operation* in 10 minutes per 24 hour day. Former time—2 hours every day and the press had to be shut down!

Your reputation as a designer benefits by the improved performance you give machines with Alemite Centralized Lubrication. They not only live longer, but make important savings because you've designed M. P. T.* into them. You also eliminate the grief and expense of costly field service. All good reasons for giving *your* machines the sales advantage of this famous "lifeline."

**More Productive Time*

Sit at Your Desk and See Alemite Systems Work!

Send coupon below, requesting "no obligation" demonstration of the four new Alemite Centralized Systems. An Alemite Lubrication Specialist will demonstrate with transparent working models right at your desk. He will also explain how you can design these systems into your machines.... Just send the coupon.

Alemite, 1804 Diversey Parkway, Chicago 14, Illinois

Have an Alemite Lubrication Specialist call and demonstrate the four new Alemite Centralized Systems of Lubrication.

*Company*_____

*Name*_____

*Address*_____

*City*_____ *State*_____

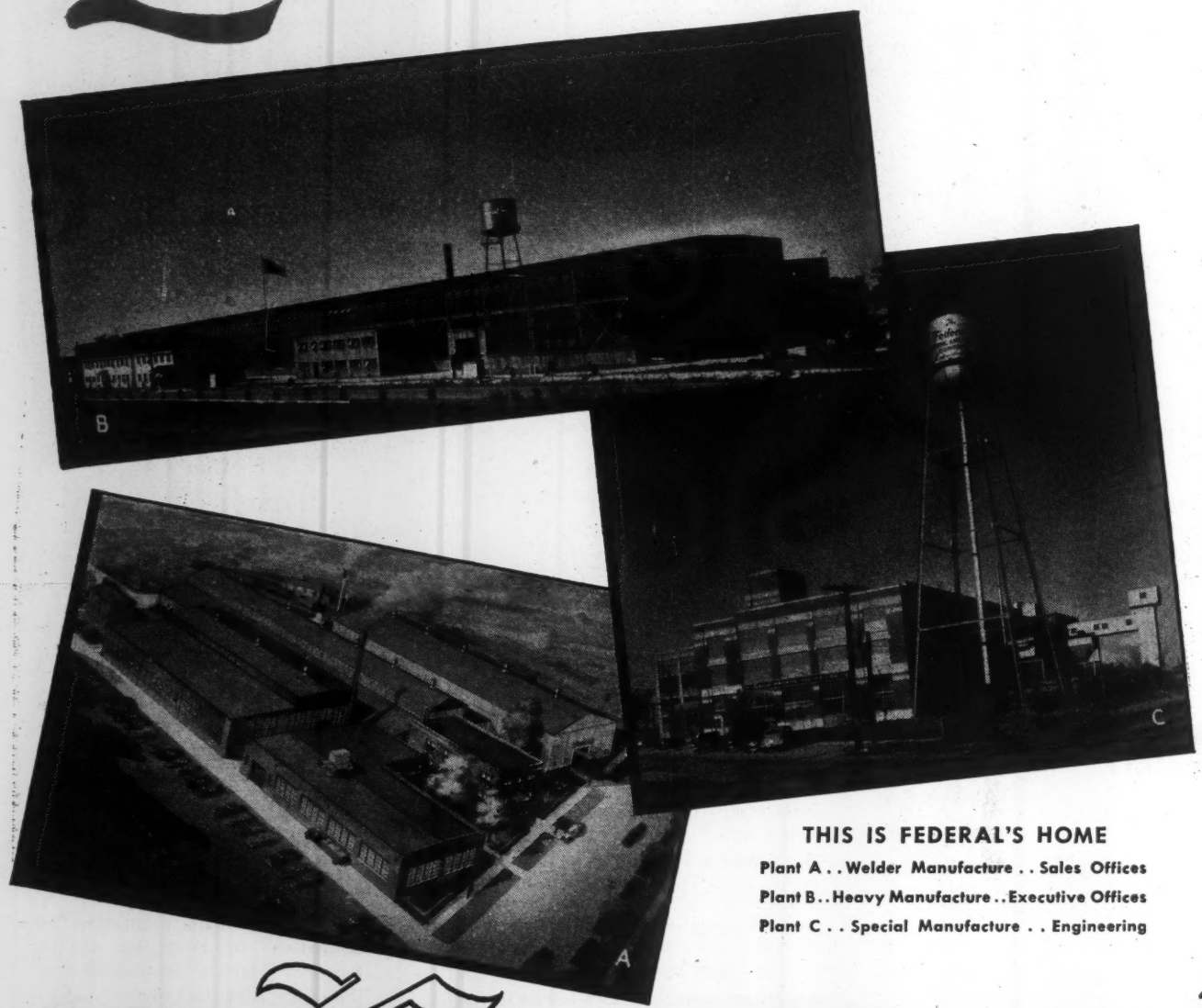
Another Product of STEWART WARNER

ALEMITE

First in Modern Lubrication

CONSULTATION • ENGINEERING • EQUIPMENT • LUBRICANTS • MAINTENANCE

Let us now Produce...



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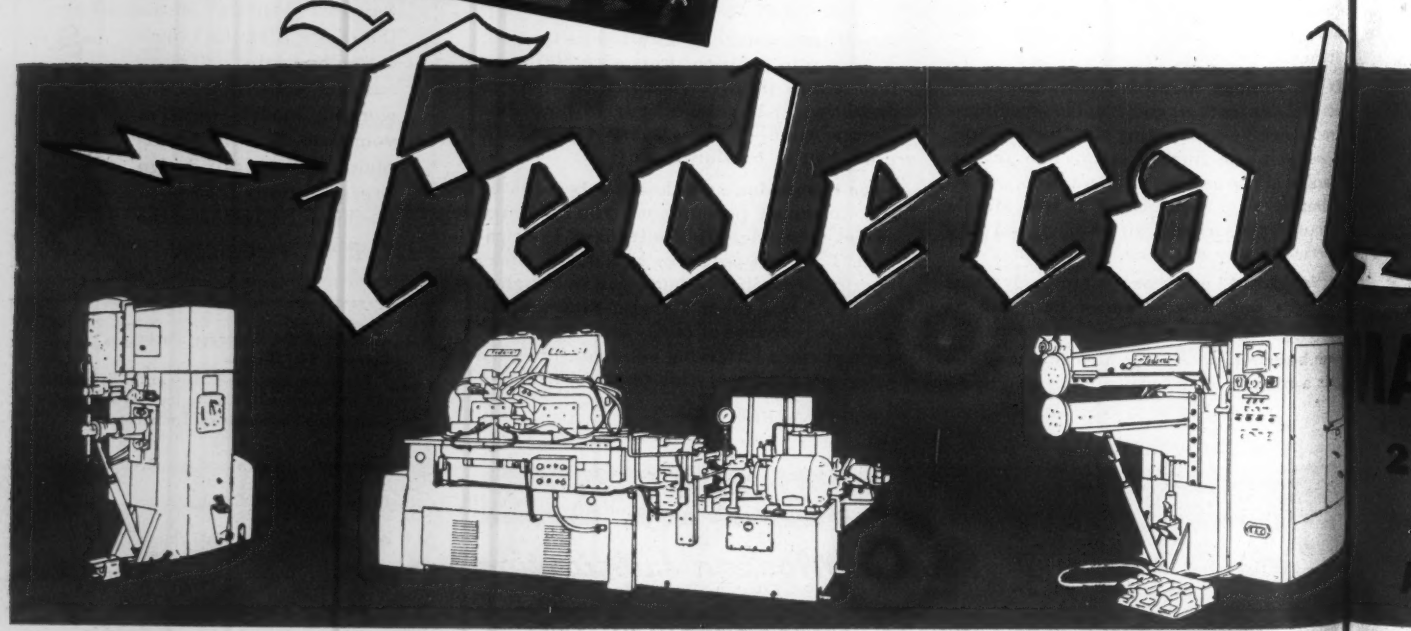
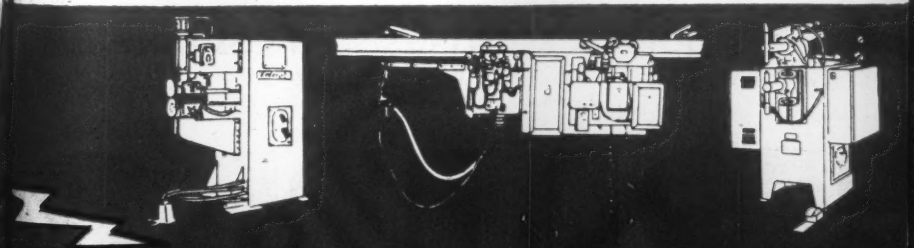


...goods for the good of man"

This seems like a good time to be practical about New Year's Greetings to you who turned in such a tremendous job of production for war and now face the no less critical problem of producing of "goods for the good of man".

The most practical way we know to back up any wish for a happy and prosperous year is to re-state our ability and eagerness to provide means to improve production . . . tools that cut the corners of cost and time in metal fabrication . . . that is the sort of aid to happiness and prosperity on which we can personally deliver.

All of us, from the factories where Federal Resistance Welding Machinery is made, and from the many branch offices through which we wish to serve you, recognize the immensity of the challenge ahead. At the same time, we DO wish you a Happy New Year . . . practically *and* sentimentally.



MACHINE and WELDER CO.

228 DANA STREET • WARREN, OHIO

Manufacturers of

ALL TYPES OF RESISTANCE WELDERS

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Henry F. Smith and Son
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Cleveland (15), Ohio
H. L. McCreery and Son
2036 E. 22nd Street

Dallas (1), Texas
Perry Machinery Co.
409 S. Akard St.

Detroit (11), Michigan
Kilpatrick and Martin
2382 E. Grand Blvd.

Fort Wayne, Ind.
Wayne Welding Supply
513 East Wayne St.

Houston (6), Texas
Perry Machinery Co.
2613 Milan St.

Los Angeles (15), California
Sullivan-Cassimus Company
110 W. Pico Blvd.

New Orleans (12), Louisiana
Frederick and Baker
725 Canal Building

New York City (7)
A. A. Probeck & Company
50 Church Street

Philadelphia (6), Pennsylvania
The Federal Machine & Welder Co.
Bourse Building

Pittsburgh (22), Pennsylvania
Leonard R. Nourie
Park Building

Seattle (22), Washington
Sullivan Cassimus Co.
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St. Louis (8), Missouri
C. O. Schumacher
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San Francisco (7), California
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Dudley, England

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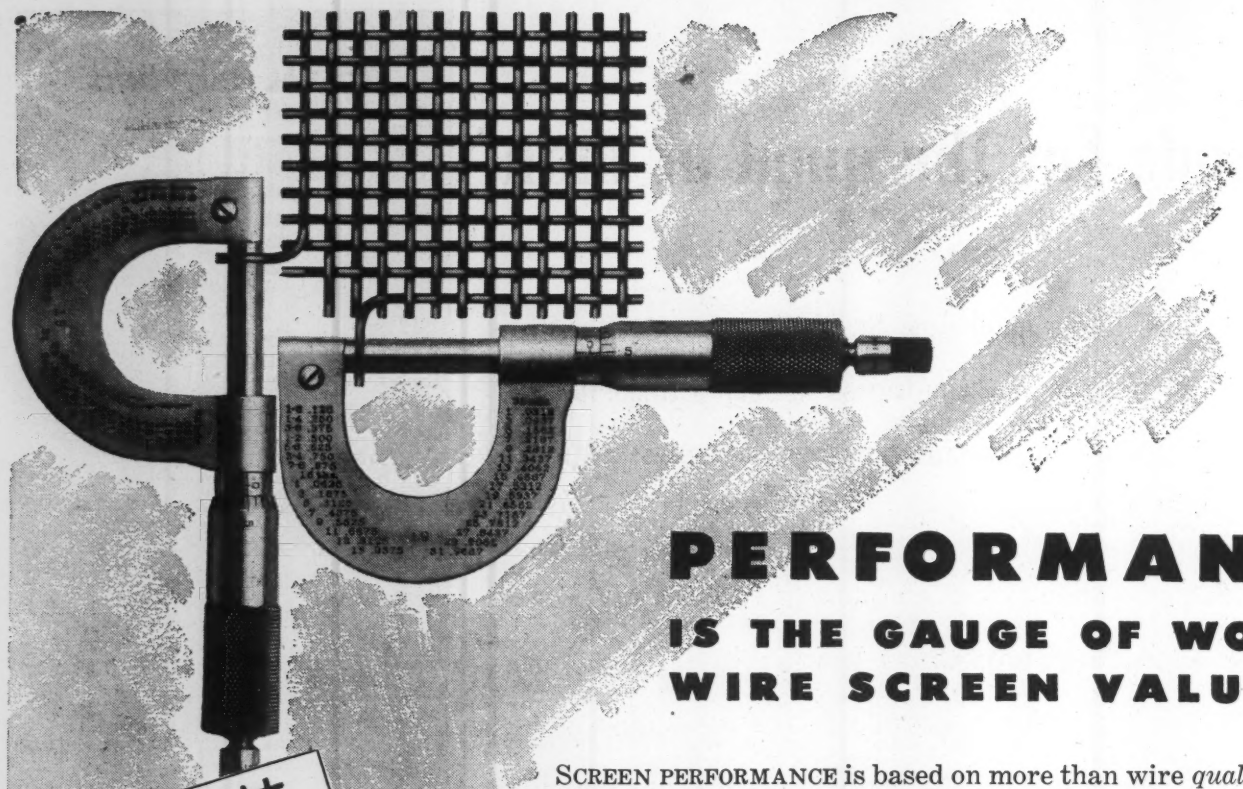
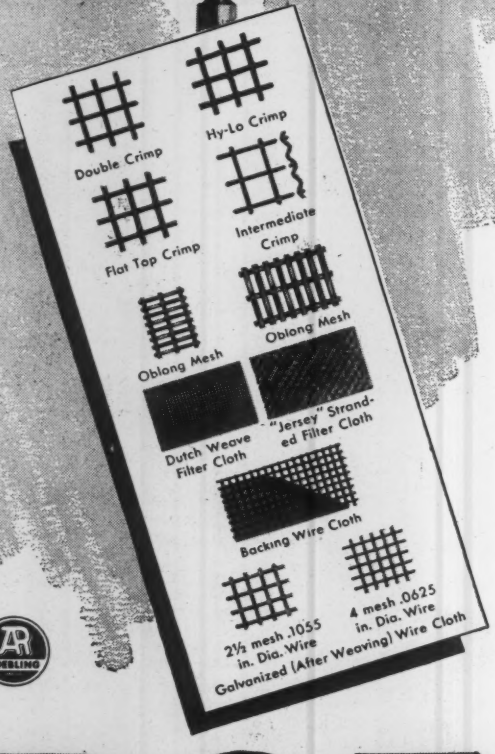


PERFORMANCE
IS THE GAUGE OF WOVEN WIRE SCREEN VALUE...



SCREEN PERFORMANCE is based on more than wire *quality* alone. Careful engineering, proper design, selection of suitable metals, and manufacturing "know how" all count in a woven wire screen's ability to give long, useful service. Roebling Woven Wire Screens have this ability because *they are made to fit the job.*

Before a wire screen is supplied, each requirement to be met in use is carefully checked. The type and consistency of material to be screened, the kind of equipment involved, and the working conditions likely to be met are all considered. The correct screen is then selected from a complete range of mesh sizes, wire diameters, metals, weaves and edgings.

This attention to correct application—plus Roebling's century of experience in making fine wire products—is your guarantee of getting the best screen for your every screening operation.

Roebling Woven Wire Screens are improving and speeding the screening of all types of materials in many plants today. Why not call in a Roebling engineer to see what they can do for you?

Woven Wire Fabrics Division

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WIRE ROPE AND STRAND • FITTINGS • SLINGS • ROUND AND SHAPED WIRE • WIRE CLOTH AND NETTING • AERIAL WIRE ROPE SYSTEMS • SUSPENSION BRIDGES AND CABLES • COLD ROLLED STRIP • AIRCORD, SWAGED TERMINALS AND ASSEMBLIES • HIGH AND LOW CARBON ACID AND BASIC OPEN HEARTH STEELS • ELECTRICAL WIRES AND CABLES

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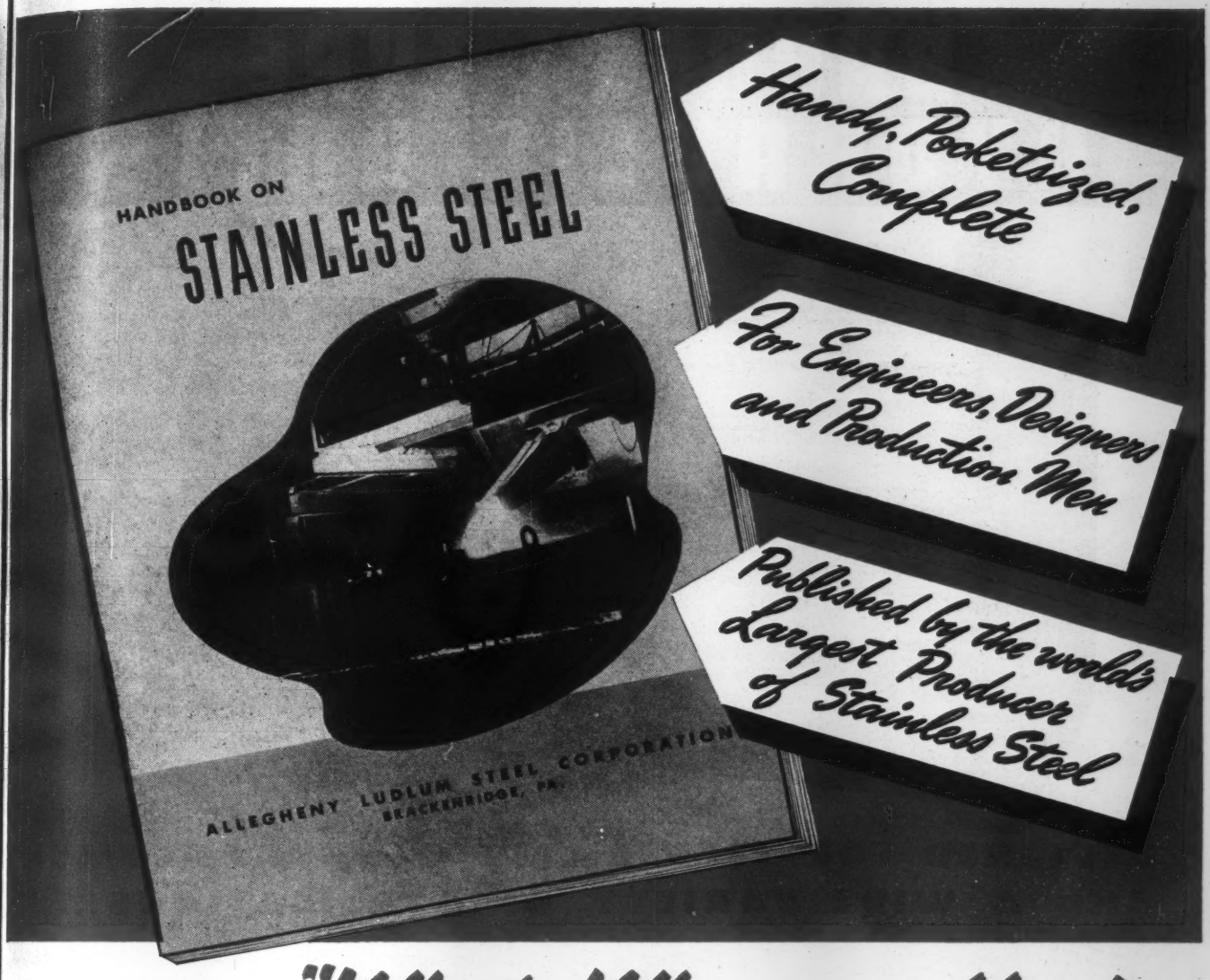


HERE'S THE "What, Why and How" OF ALLEGHENY METAL

★ **ALLEGHENY METAL, the time-tested stainless steel, is produced in types and grades to meet any ordinary or special requirement, and in all necessary forms and shapes—backed by any needed assistance from our Technical or Research Staffs.**

★ ***Allegheny Metal is also handled and carried in stock by all Ryerson warehouses.***

ALL the various commercial grades of stainless steel have reason and meaning. Here's the data you need to match up the proper grade of Allegheny Metal with the product whose efficiency, appearance or service life you want to improve . . . the problem of corrosion and heat resistance, sanitation or maintenance you want to solve . . . the methods of fabrication you need to use. You'll find this new 100-page Handbook an invaluable mine of handy information.

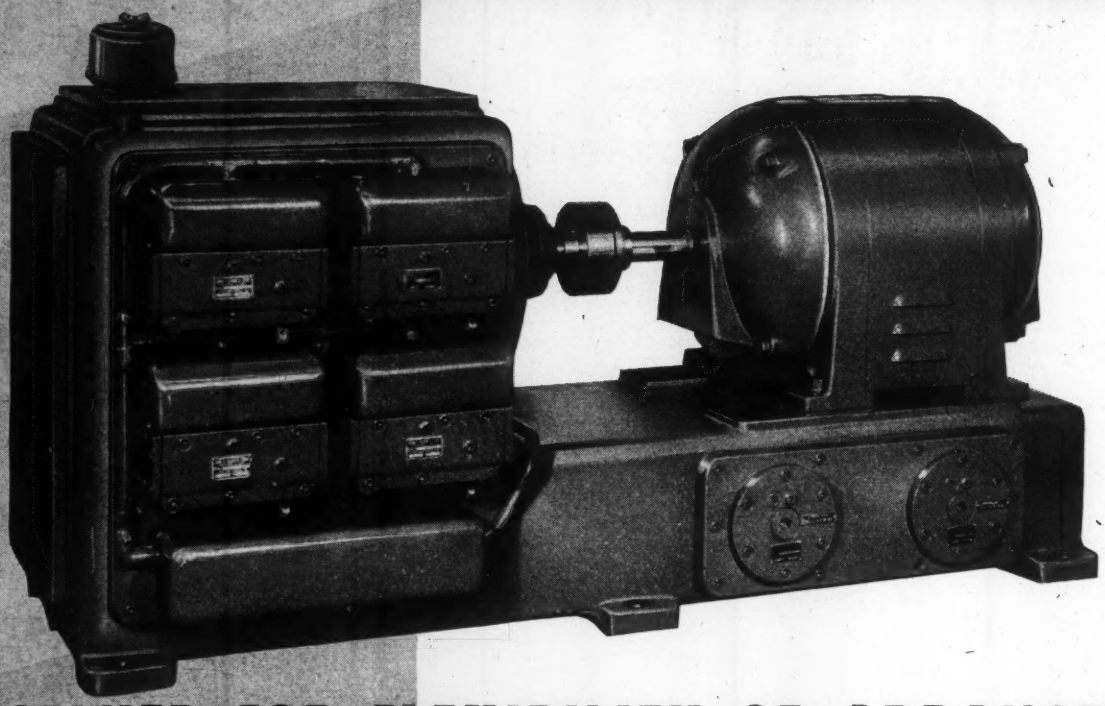
write for your copy . . . **Address Dept. MD-36**

ALLEGHENY LUDLUM

STEEL CORPORATION · General Offices, Brackenridge, Pa.

Pioneer in Specialloy Steels

BARNES L-TYPE HYDRAULIC UNITS



DESIGNED FOR FLEXIBILITY OF ARRANGEMENT AND A WIDE VARIETY OF APPLICATIONS...

Write for

THIS NEW CIRCULAR

Gives general description, details of construction, and principal engineering data on three standard sizes of BARNES L-Type Hydraulic Machine-Control Units.

Many different machine-control circuits can be built into the basic structure of this new hydraulic control unit, to provide almost unlimited versatility at moderate cost. Valves and piping connections *to suit YOUR individual application* are mounted as required on the side panels, with a direct-drive motor and pump of proper size. Three standardized sizes cover all needs from 2 to 15 horsepower. BARNES Hydraulic Units are delivered completely assembled and factory-tested, ready for easy and rapid attachment to your machine.

Rear view of unit shown above, illustrating additional valves and all piping connections arranged, in this instance, on the back panel.

Features OF L-TYPE UNITS

- COMPACT, SELF-CONTAINED
- DIRECT DRIVE TO PUMP
- THREE STANDARD SIZES
- RIGHT OR LEFT-HAND
- FOOT OR SIDE MOUNTING
- VALVES TO SUIT APPLICATION
- CONVENIENT TERMINALS
- PROTECTIVE FILTERS
- COMPLETE ACCESSIBILITY

John S. Barnes Corporation

350 South Water Street
ROCKFORD, ILLINOIS

DETROIT OFFICE: 503 New Center Bldg.

NEWARK OFFICE: 660 Industrial Office Bldg.

Sperry FOUND A BETTER WAY

TO HOLD MACHINE PARTS TOGETHER

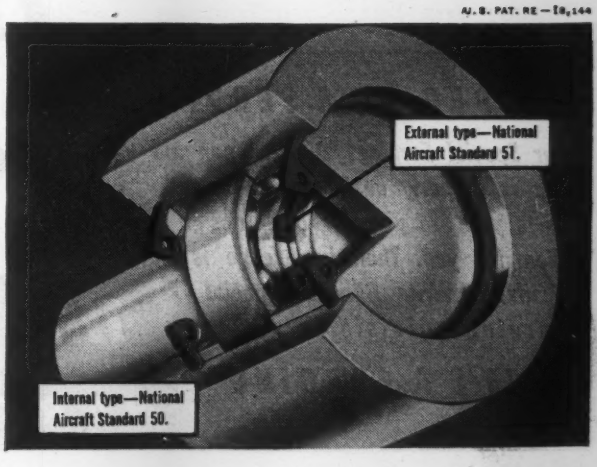
WALDES TRUARC RETAINING RINGS

Before using Waldes Truarc Retaining Rings in Sperry gunsights, Sperry Gyroscope Co. engineers had difficulty with important taper pins working loose while the gunsights were in service. Due to vibration, pins occasionally loosened and fell out affecting the accuracy of the gunsights. Frequent, thorough inspection of taper pins in use didn't entirely solve the problem.

Then they specified Waldes Truarc Rings. Where taper pins had previously worked loose, the rings now held them fast. Assembly of the gunsights became much easier and quicker. Because of this earlier experience, Sperry used Waldes Truarc Rings as original equipment in their K-13 Compensating Gunsights. And Truarc *exceeded* their highest requirement for dependability in action.

Waldes Truarc Retaining Rings are used to save weight, space, cost and man-hours in a wide range of products. For holding and positioning machine parts they offer definite advantages over nuts, shoulders, collars, and pins. They simplify and speed up production. They can be put on and taken off again and again —and still retain the perfect circularity which gives them their unfailing grip. Test them yourself. We'll furnish samples and complete data. Write Dept. L-12.

U. S. PAT. RE—18,144

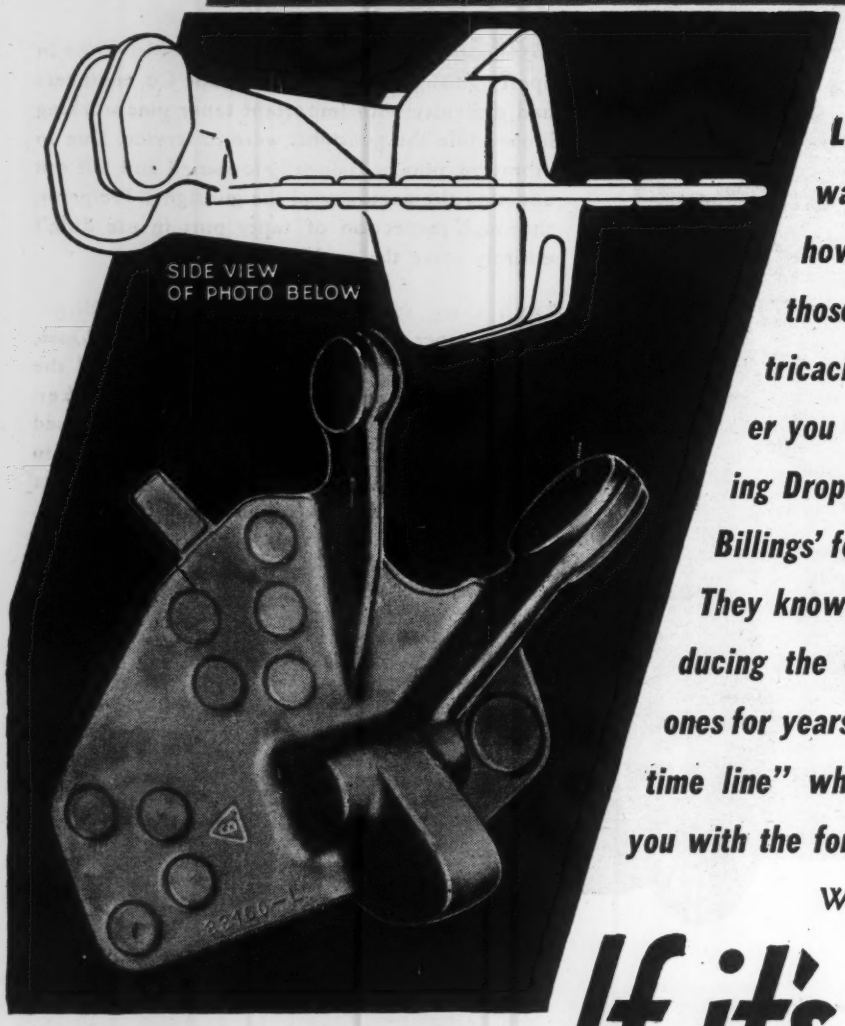


WALDES TRUARC TRADE MARK **RETAINING RINGS**

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

CANADIAN REPRESENTATIVES: PRENCO PROGRESS CORP., LTD., 72-74 STAFFORD ST., TORONTO

Billings FORGINGS



Looks like a "tough one" doesn't it? It was but Billings produced it! Notice how far metal had to be moved to fill those arms and bosses, imagine the intricacies of die locks — but, why bother you with the technicalities of making Drop Forgings? That's our job. Let Billings' forging engineers do it for you. They know forgings! We've been producing the easy ones and the tough ones for years. . . . In that new "peacetime line" why not let Billings help you with the forged parts?

WRITE OUR SPECIAL FORGINGS DIVISION

If it's a Forging- See Billings

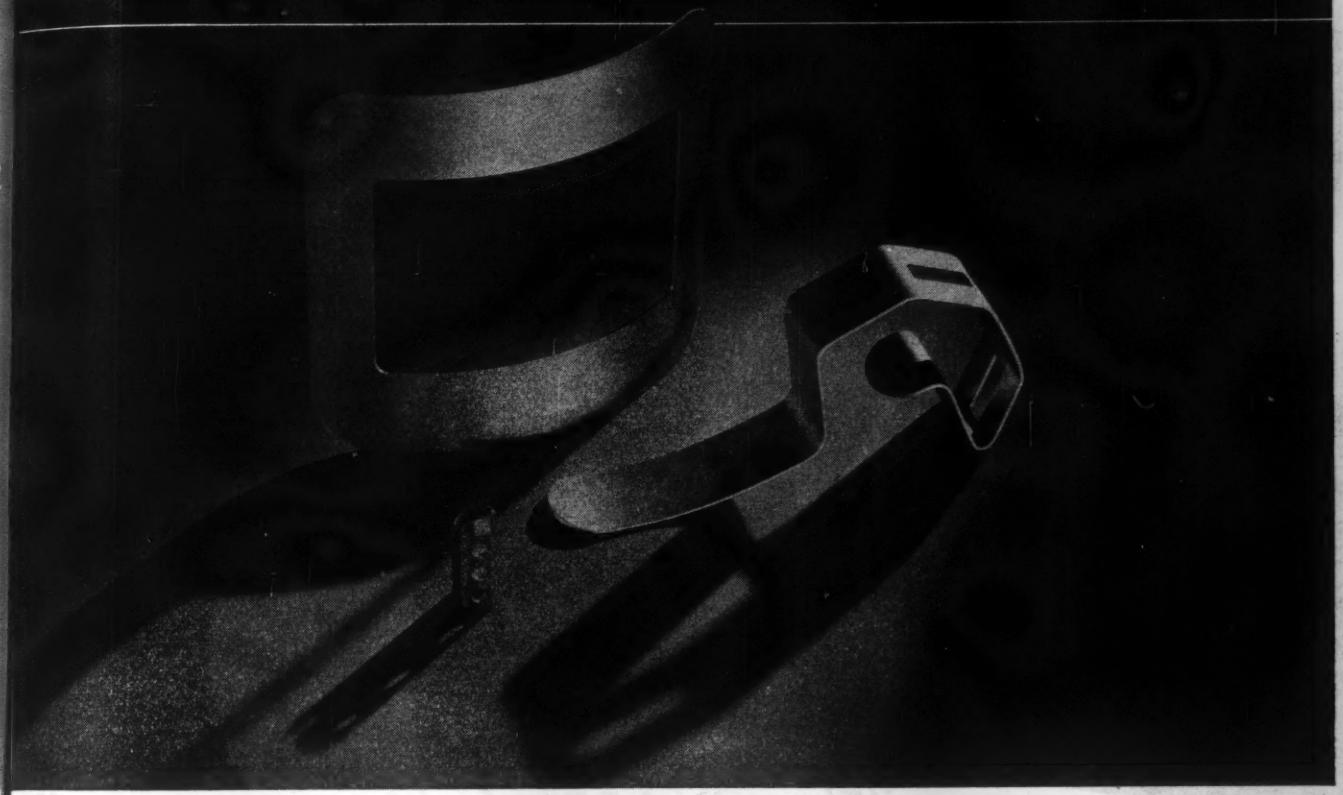
RENDERING A SERVICE

Our Special Forgings Division can aid you in properly designing the forged parts you are planning or to design them for you. Their knowledge is available. Write Billings' Special Forgings Division.

IF IT'S A FORGING

THE BILLINGS & SPENCER CO.
MAIN OFFICE AND PLANT
HARTFORD, CONN. U. S. A.

the *unusual* in Springs is *not unusual* at Muehlhausen

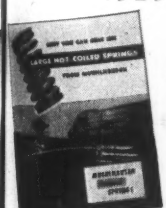


★ Muehlhausen is providing the answers to many challenging spring problems—providing them at a speed that will satisfy pent-up demands. Unusual spring requirements are being met with unusual spring designs—made possible by the lessons learned in a quarter century of spring manufacture.

Little springs and big springs, in quantities large and small—tiny springs for the "goose pimple" temperature of refrigerators, or heat toughened giants for oven hot rolling mill jobs—all are part of everyday production.

Give your product designers greater latitude and give your product longer life—with Muehlhausen springs.

MUEHLHAUSEN SPRING CORPORATION
Division of Standard Steel Spring Company
525 Michigan Avenue, Logansport, Indiana



SEE HOW SPRINGS ARE HOT-COILED

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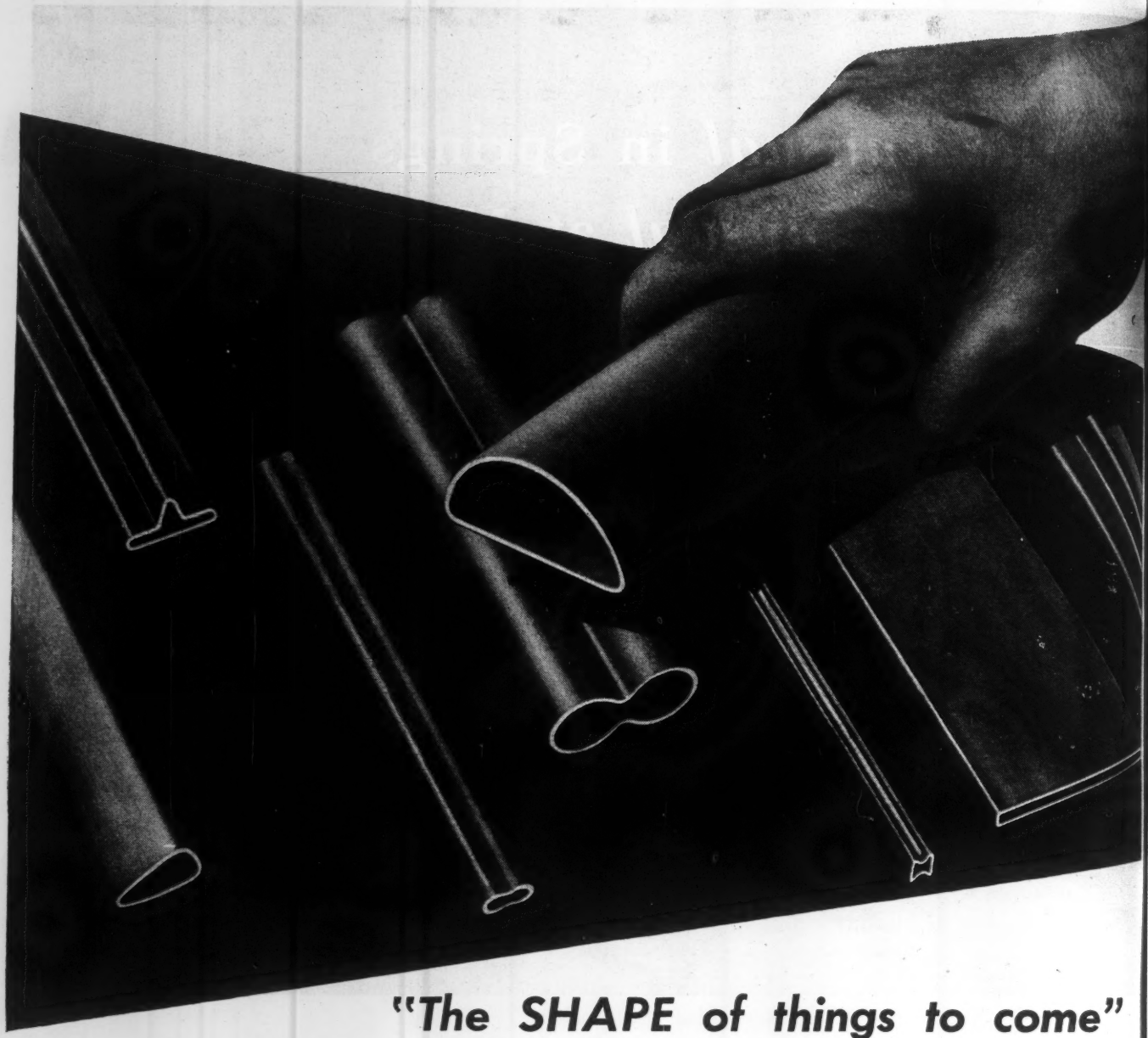
New booklet illustrates important steps in hot-coiling large springs. Send for copy today.

MUEHLHAUSEN SPRINGS

EVERY TYPE AND SIZE



"The SHAPE of things to come"

Each of these special shapes produced by Summerill
was designed to do some particular job better, and at lower cost,
than by some other method. Each will play an
important role in vastly different fields of use—
the Rubber Industry—the Oil fields—
in electrical and other household appliances.
Who knows the shape of things to come?
Today Summerill is producing steel tubing shapes
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We know that tomorrow will bring new problems to test
the ingenuity of Summerill craftsmen.

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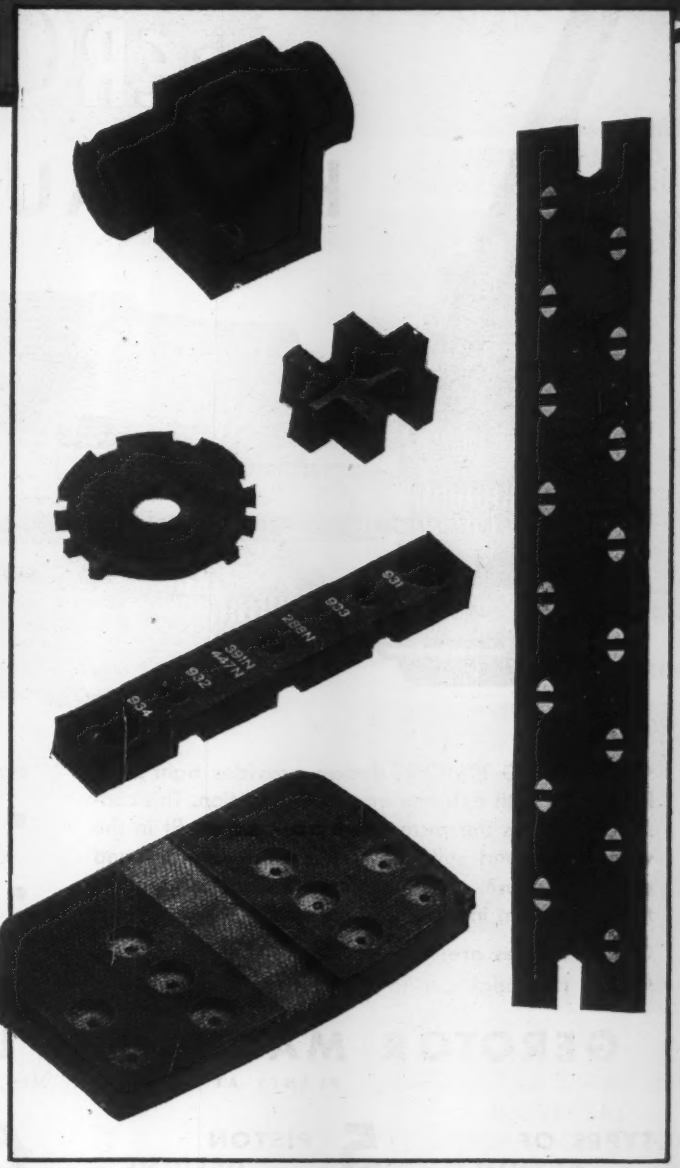
Use Panelyte Fabricated Parts where corrosion is a Problem

Panelyte laminated plastic parts are not affected by water, brine, oil, ordinary solvents, coolants, ketones, esters, weak acids or alkalis. Having good electrical properties combined with unusual structural strength, dimensional stability, and excellent heat resistance, Panelyte is thoroughly dependable and adaptable. Easily machined to exact specifications, weight-saving Panelyte parts are mass-produced in our new plant.

Our policy of working closely with customers' engineering departments enables us to give designing aid, and from performance data on hand, to make accurate estimates on the service life of proposed applications.

Inquiries are invited on sheets, rods, tubes, and *molded* as well as fabricated parts. Write for factual "Engineering Data Book".



Typical examples of lathe turning, grooving, printing, milling, shaving, and die-punching.

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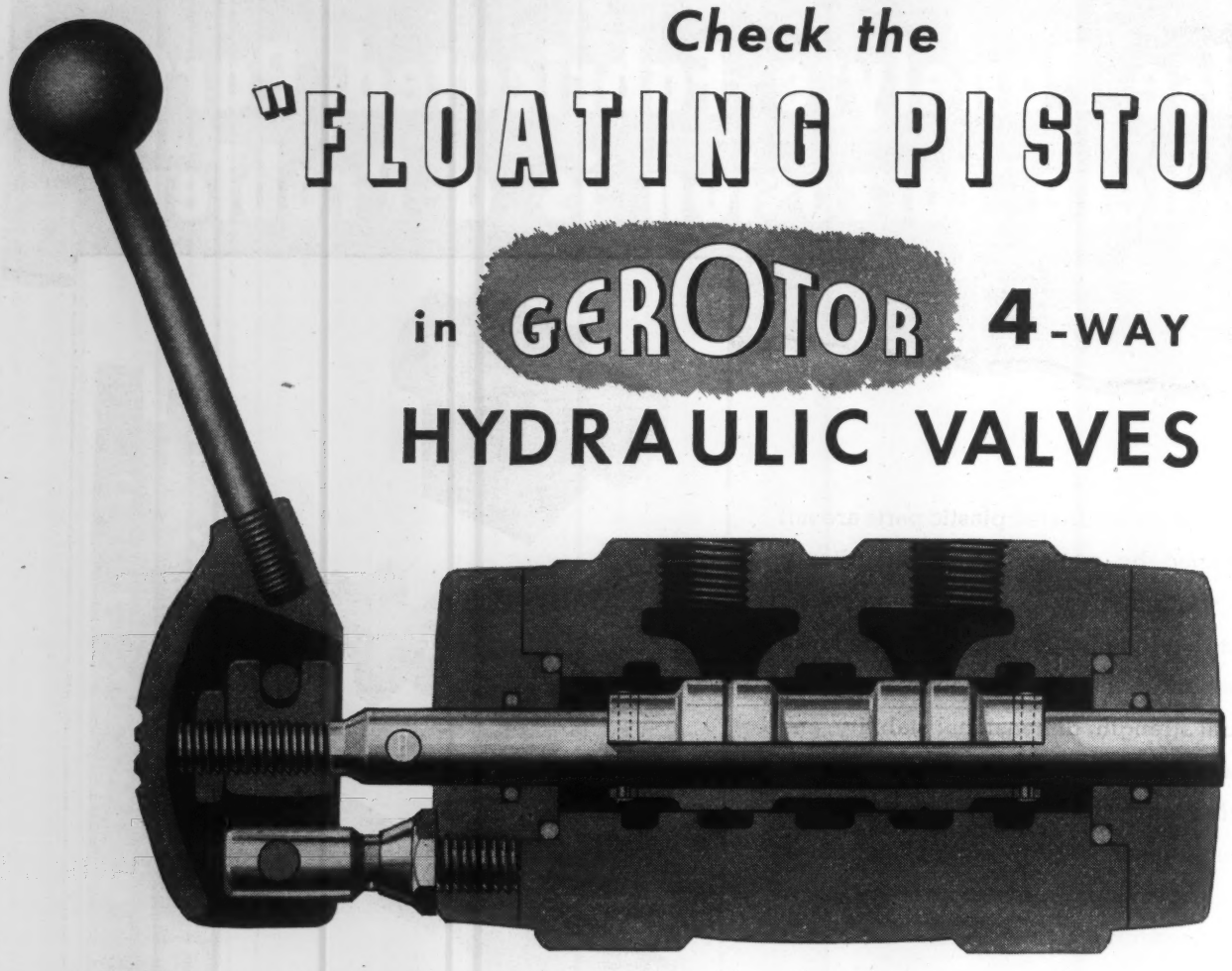
Check the

"FLOATING PISTON"

in GEROTOR 4-WAY HYDRAULIC VALVES



● "FLOATING PISTON" design provides tight sealing ability with extreme ease of operation. This construction gives the piston a close precision fit in the valve bore and still allows it to move freely and easily, because such movement is independent of the valve stem in the valve covers.

Other features are:

● "O" ring seal design prevents oil from leaking past piston stem and reduces friction.

● "O" ring seal on valve covers assures positive sealing with no gasket.

● Large oil passages allow full capacity flow.

Send for Catalog showing complete line of Gerotor Hydraulic Valves, Cylinders, Pumps and Pump Units.

GEROTOR MAY CORP., LOGANSPORT, IND.

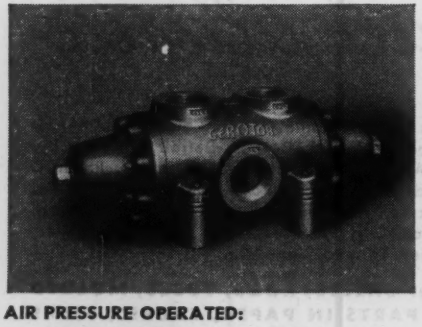
PLANTS AT BALTIMORE, MD., LOGANSPORT, IND.

4 TYPES OF ACTION
Standard, Spring Return, Spring Centered, Ball Detent.

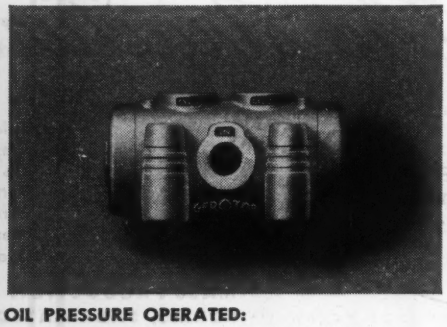
5 PISTON DESIGNS
To meet the requirements of any hydraulic circuit.

6 TYPES OF OPERATION
Hand, Foot, Cam, Solenoid, Oil operated, Air operated.

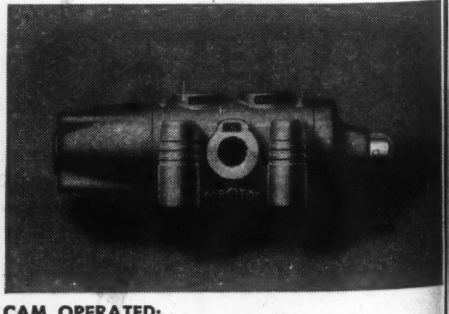
7 SIZES
¼", ⅜", ½", ¾", 1", 1¼", and 1½".



AIR PRESSURE OPERATED:
Gerotor 4-Way Hydraulic Valve.



OIL PRESSURE OPERATED:
Gerotor 4-Way Hydraulic Valve.



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Gerotor 4-Way Hydraulic Valve.

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UNIVERSAL TOOL GRINDERS
ARE READY...

MULTIPLE SPEED
UNIVERSAL TOOL GRINDER

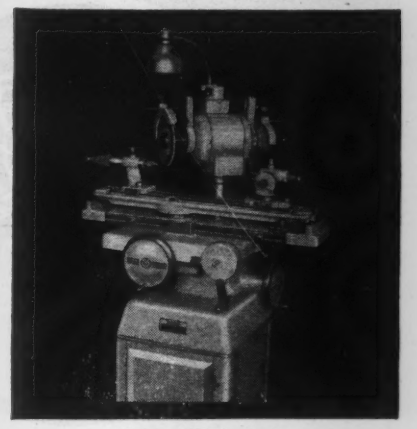
For postwar production and maintenance too . . .

Ready! Yes, ready to serve on the tremendous job which is still ahead. When the war began *Knock-Out* Tool Grinders were ready and served their country and Allied Nations well. Now, as reconversion becomes a reality *Knock-Out* Grinders are once again ready to take their place on the production line and on tool maintenance work.

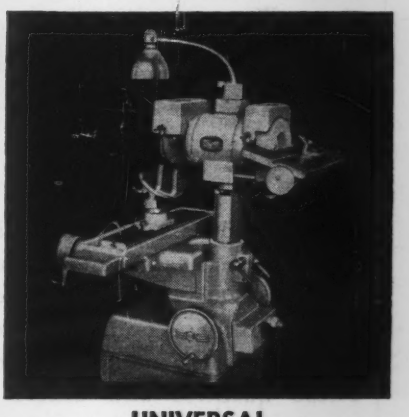
A product is no better than the tools with which it is cut and shaped. Keep those tools sharp and keep them right! Whether you're using high speed steel or carbide tipped cutting tools, there is a K-O Grinder built to accommodate your needs. The low original cost and negligible upkeep on *Knock-Out* Grinders makes hiring others to do cutting tool maintenance highly impractical.

Knock-Out Engineers have made available more time-tested grinder fixtures than has any other manufacturer. If it can be done—it can be done more easily and economically on a K-O Grinder.

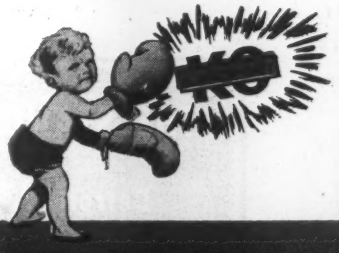
Get in touch with *Knock-Out* at Aberdeen or with your nearest K-O distributor.

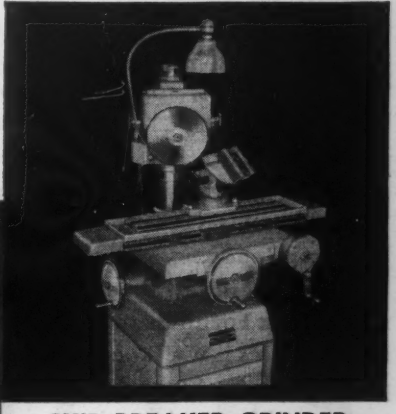


SINGLE SPEED
UNIVERSAL TOOL GRINDER



UNIVERSAL
CARBIDE TOOL GRINDER



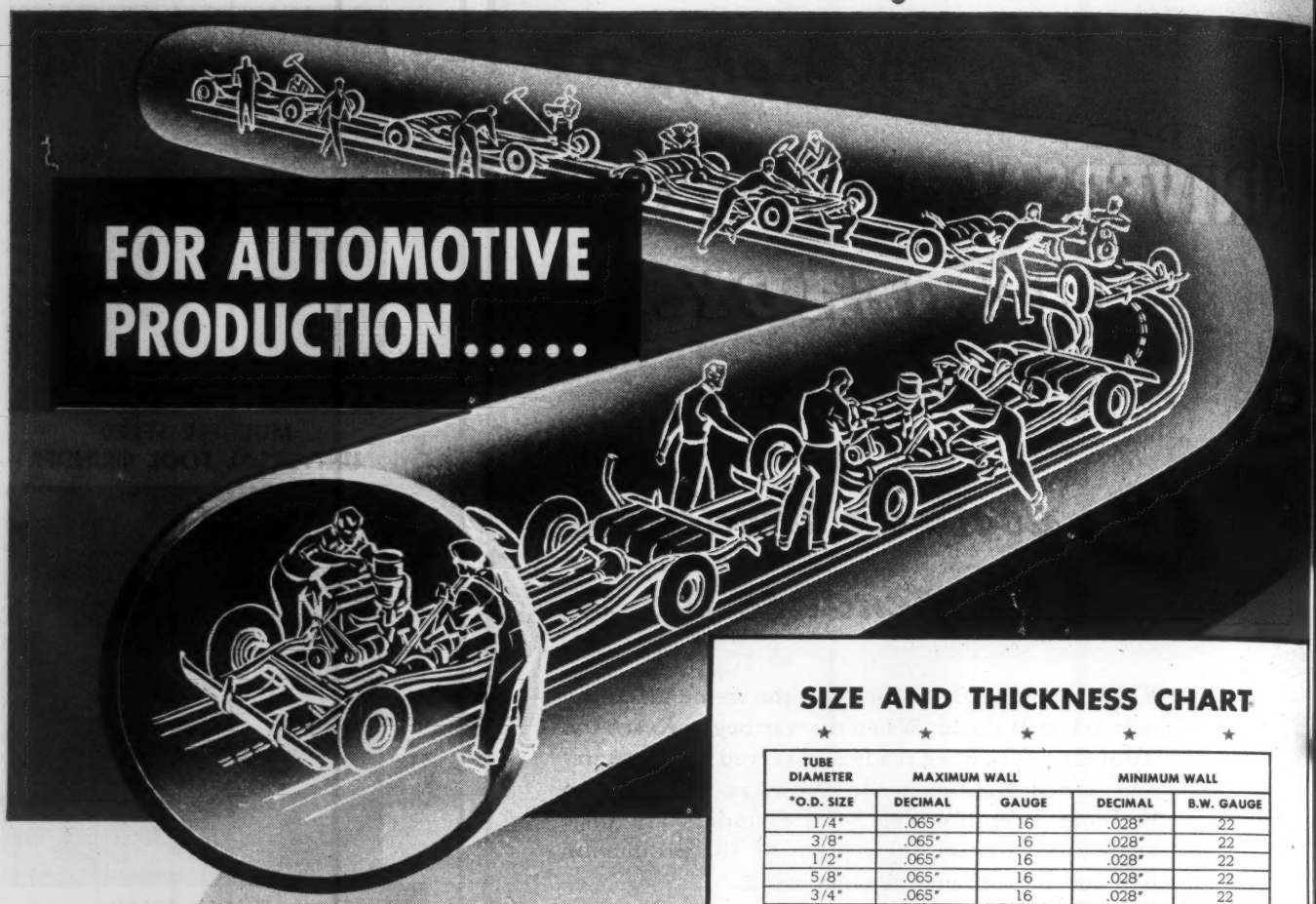


CHIP BREAKER GRINDER

See Your Nearest Distributor Or Write To

K. O. LEE COMPANY--ABERDEEN, S. D.

Manufacturers of fine tools and equipment for over thirty years



STANDARDIZE WITH

"Standard"

ELECTRIC WELDED STEEL TUBING

The modern automobile employs tubular construction in at least 35 different places. ELECTRIC WELDED STEEL TUBING is preferred for use at a majority of these points, because of its lightness, strength and all-around uniformity.

These qualities and others make "STANDARD" ELECTRIC WELDED STEEL TUBING preferred by many automobile and automotive equipment manufacturers. They find that at points where uniformity of all factors is all-important—in such parts as steering columns, propeller shafts, torque tubes and axle housings—"STANDARD" ELECTRIC WELDED STEEL TUBING is unsurpassed.

We have facilities for the manufacture of ELECTRIC WELDED STEEL TUBING in all the gauges and diameters shown on the accompanying chart. We also have facilities for the manufacture of tubular and solid Upset Forgings in all standard and many specialized varieties. We'll be glad to work with you on any production problem in either category. For information without obligation, contact our sales representatives or write us direct.

SIZE AND THICKNESS CHART

★ ★ ★ ★ ★

TUBE DIAMETER	MAXIMUM WALL		MINIMUM WALL	
*O.D. SIZE	DECIMAL	GAUGE	DECIMAL	B.W. GAUGE
1/4"	.065"	16	.028"	22
3/8"	.065"	16	.028"	22
1/2"	.065"	16	.028"	22
5/8"	.065"	16	.028"	22
3/4"	.065"	16	.028"	22
7/8"	.065"	16	.028"	22
1"	.095"	13	.028"	22
1-1/8"	.083"	14	.028"	22
1-1/4"	.095"	13	.028"	22
1-3/8"	.095"	13	.035"	20
1-1/2"	.109"	12	.035"	20
1-5/8"	.120"	11	.035"	20
1-3/4"	.120"	11	.035"	20
1-7/8"	.120"	11	.035"	20
2"	.165"	8	.035"	20
2-1/4"	.180"	7	.035"	20
2-1/2"	.203"	6	.035"	20
2-3/4"	.203"	6	.049"	18
3"	.220"	5	.049"	18
3-1/4"	.220"	5	.065"	16
3-1/2"	.238"	4	.065"	16
3-3/4"	.238"	4	.065"	16
4"	.250"	3	.065"	16
4-1/4"	.250"	3	.065"	16
4-1/2"	.250"	3	.065"	16
4-3/4"	.250"	3	.065"	16
5-1/2"	.134"	10	.083"	14

*Intermediate sizes within the range indicated can also be manufactured. Please consult us for sizes not listed.

THE STANDARD TUBE CO.

Detroit 3, Michigan

Welded Tubing — Steel Forgings

★ *Complete Tube Stocks Maintained by* ★

STANDARD TUBE SALES CORP., One Admiral Ave., Maspeth, L. I., N.Y.
LAPHAM-HICKEY COMPANY, 3333 W. 47th Place, Chicago 32, Ill.
UNION HARDWARE & METAL CO., 411 E. First St., Los Angeles 54, Cal.

Marks the Spot to Ask Yourself Questions

When you draw the familiar "X" symbol to indicate a valve in plans for any product involving fluid control, stop and ask yourself these questions . . .

WILL it live up to the guarantee of the complete product, or will it soon start trouble and give the product a "black eye"?

WILL it assure the lowest cost in the long run, or will the saving of a few cents now be paid out many times over in later servicing costs?

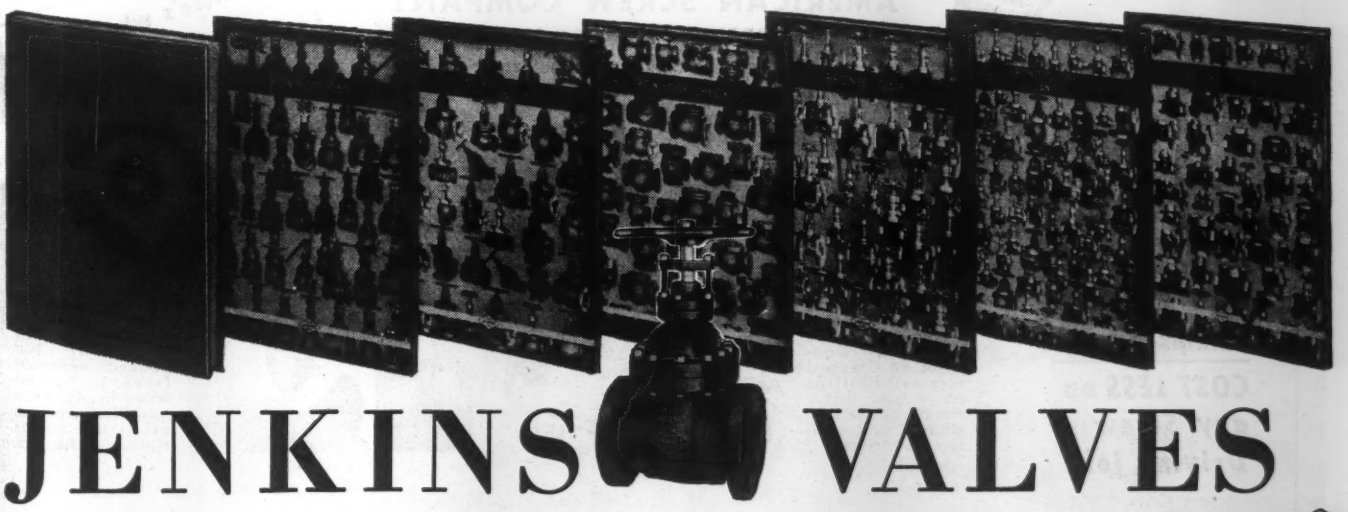
WILL the name on the valve signify "quality" to the product buyer, or is it relatively unknown, requiring that much extra sales effort?

IS the valve pattern the very best for the service, or am I overlooking some other pattern that would improve the product and add a sales advantage?

You can make sure of the right answers to these questions if you specify JENKINS whenever you specify VALVES. They have an 80 year record of top-notch quality, based on money-saving, trouble-free performance. And the famous Jenkins "Diamond" trade mark is known everywhere as the mark of trustworthy valves.

For the right answer to any questions on valve selection or application, talk to a Jenkins Sales Engineer. Give your product and its purchasers, the *extra value* of Jenkins Valves. Over 600 patterns for every service.

Jenkins Bros., 80 White Street, New York 13; Bridgeport, Conn.; Atlanta, Boston, Philadelphia, Chicago, San Francisco. Jenkins Bros., Ltd., Montreal, London.



JENKINS VALVES

BRONZE • IRON • STEEL AND CORROSION-RESISTING ALLOYS • 125 to 600 lbs. PRESSURE

TRADE JENKINS MARK

Jenkins Bros.

Sold through Reliable Distributors Everywhere

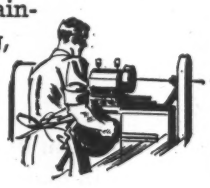
4 INSPECTIONS!

That's why Screw and Bolt Buyers Say:

"AMERICAN brand is 100% OK!"

1. Raw Material Inspection: Every month, American buys hundreds of miles of steel, brass, bronze, and everdur. And every lot is checked for quality before going into production.

2. Process Inspection: Product-samples are checked every few minutes to make sure that machines are maintaining accuracy on every process . . . heading, slotting, shaving, threading.



3. Head, Thread & Point Inspection: Moving along on conveyor belts, screws are individually checked to make sure there are no burred heads, drunken threads, or dull points.

4. Automatic Weigh-Count: Each newly filled box of screws is weighed against a counted gross, to make sure that there are at least 144 perfect American Screws in every gross-box.

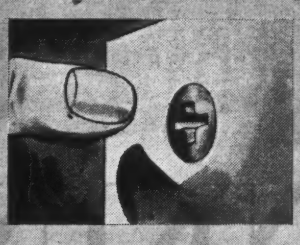
American's modern, high-speed manufacturing methods . . . checked by these four inspections . . . are easy-to-see reasons why more and more screw and bolt buyers are marking their orders: "American brand . . . don't substitute."

AMERICAN SCREW COMPANY
PROVIDENCE 1, RHODE ISLAND
Chicago 11: 589 E. Illinois Street
Detroit: 502 Stephenson Building

Here's why you get a Higher "Perfection-Percentage" in every order for American Phillips Screws

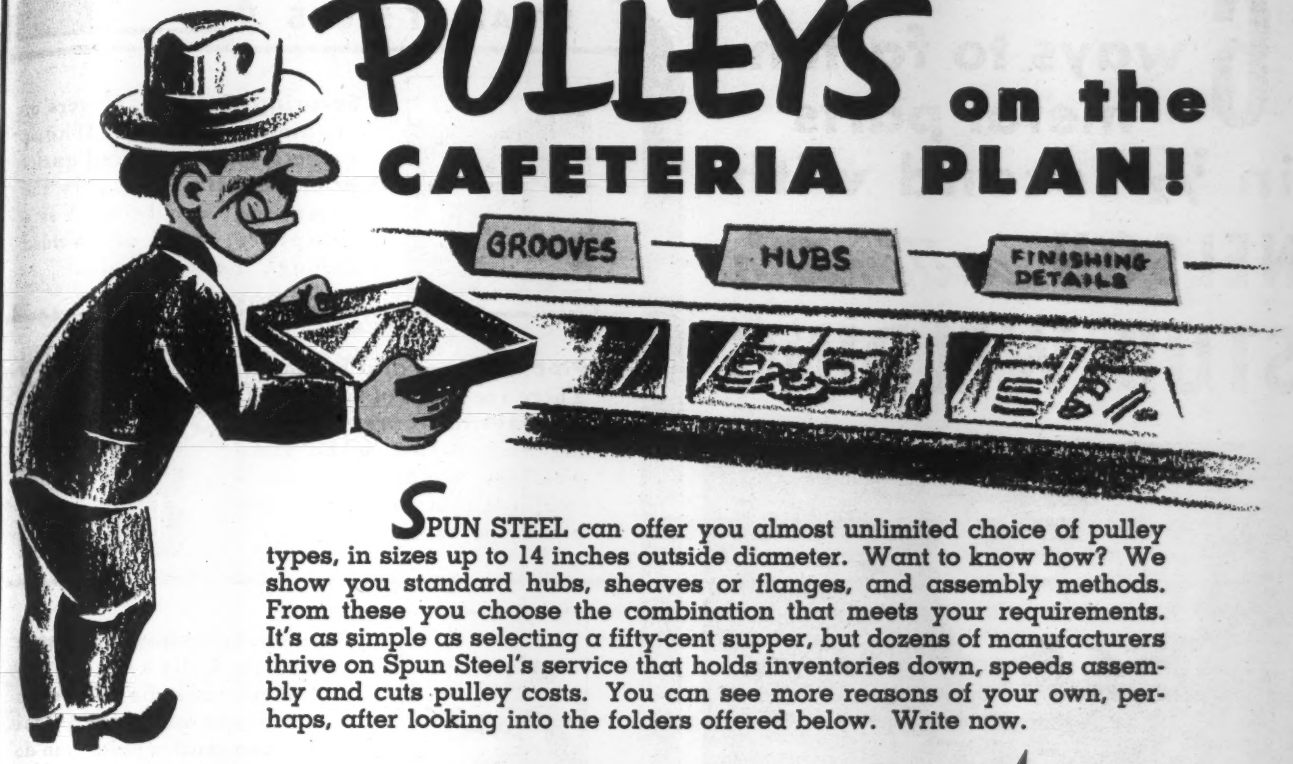
. . . and here's WHY American Phillips Screws COST LESS on any Screw Driving job

1. **Faster Starting**—One hand holds driver, other holds work. No wobbling, no dropped screws. Phillips screw and driver remain as one self-aligned unit until screw is driven.



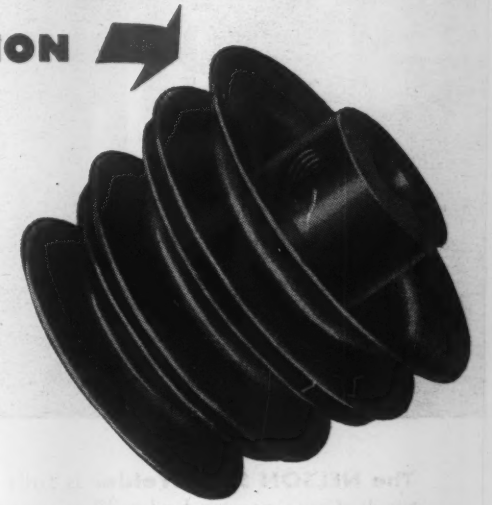
2. **Cleaner Fastenings**—*every time.* No slanted screws to back out. No gouged work-surfaces, or burred screw-heads. Even unskilled workers get skilled results right from the start.

PULLEYS on the CAFETERIA PLAN!



SPUN STEEL can offer you almost unlimited choice of pulley types, in sizes up to 14 inches outside diameter. Want to know how? We show you standard hubs, sheaves or flanges, and assembly methods. From these you choose the combination that meets your requirements. It's as simple as selecting a fifty-cent supper, but dozens of manufacturers thrive on Spun Steel's service that holds inventories down, speeds assembly and cuts pulley costs. You can see more reasons of your own, perhaps, after looking into the folders offered below. Write now.

HERE'S ONE BALANCED COMBINATION



To meet one customer's special requirements, Spun Steel produced this three-groove step pulley for A-section belts. The unit is built up of three standard A-groove sheaves assembled on a standard hub. Furnace brazing produces an integral construction.

Spun Steel's standardized A- and B-groove components make possible an endless variety of pulleys. It is readily apparent that the illustrated unit is adaptable to variable speed drives for light machine tools and accessories. If you have anything to do with design or production of automotive and aviation assemblies, farm implements, laundry equipment and other round-the-house appliances, air conditioning and refrigeration, power tools, or compressors . . . Spun Steel pulley-planning can help you put more strength in smaller space with less weight. Let's see your blueprints first!

AND HERE ARE OTHER SPUN STEEL "SPECIALS"

NOW MAILING! TWO FACT-FILLED BOOKLETS —

Write for Spun-Steel folders on Metal Engineering and Roller-Formed Steel Pulleys, the latter a reprint from Sweet's File for Product Designers, Section 4A/24, with new listing of standardized pulleys now offered from stock. See how Spun Steel processes give you better parts at lower cost.

PMI

THE Spun Steel CORPORATION

SPUNSTEEL

1209 CAMDEN AVENUE, S. W., CANTON 6, OHIO

6 ways to fasten metal parts in ½ second with NELSON *automatic* STUD WELDING

The NELSON Stud Welder is fully portable, works from any standard welding generator, and welds in any position. Studs from ⅛" to ¾" in diameter and up to 8" in length are welded with complete fusion to metal in ½ second.
To speed production, to do a *better* job faster, put this versatile tool on *your* job. The facts are yours for the asking . . .

☛ *WRITE NOW for complete information, or to arrange a demonstration in your own shop at your convenience . . .*

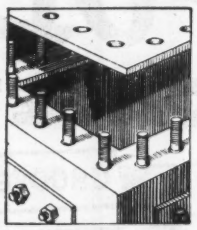
NELSON SALES CORPORATION
LORAIN, OHIO

Representatives and Distributors for

Nelson Specialty Welding Equipment Corp.
San Leandro, California

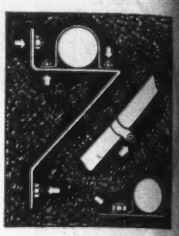
Nelson Stud Welding Corp.
Lorain, Ohio

STRAIGHT STUDS



Securing Covers: Covers of all kinds, with or without gaskets, can be secured quickly and easily. Usually the cover itself can be used as a template; studs are welded through the cover holes.

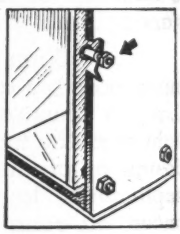
Pipe Hangers and Brackets: There are scores of faster, better ways to secure pipe, tubing or conduit with stud welding. Welds can be made in all positions; welder is completely portable.

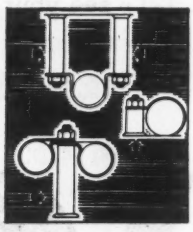


General Fastening to Metal: Wherever brackets or attachments must be secured to sheet, plate or structural metal, the stud welder can do the job at the rate of one-half second or less per weld.

SHOULDER STUDS

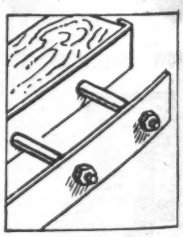
Metal Liners and Jackets: The shoulder stud provides correct spacing between liner and casing or jacket, and no holes pass through the liner which can be left smooth and unblemished.





Securing Pipe, Cable and Hose: Shoulder studs provide a fast, convenient method of attaching many types of pipe, conduit, cable, tubing or hose; three typical applications are illustrated at left.

Spacer and Bumper Bars: Spacer bars, bumpers and guard rails can be attached simply and economically with shoulder studs. Portability of the stud welder makes the job easy on large assemblies.



OTHER NELSON FLUX-FILLED STUDS

Hydraulics—

COMPLETELY ADAPTABLE TO ANY MOTION DESIRED

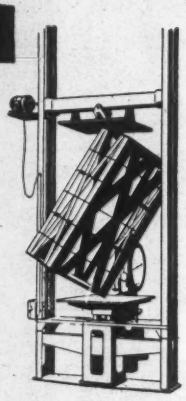
"Hy-Mac" Hydraulic Power Units can be applied to drilling, grinding, milling, boring, piercing, riveting, broaching, pressing . . . just determine the functions of the machines that are to be hydraulically operated—and our engineers will recommend a Power Unit and a layout of circuits to best do the job . . . For feed and traverse of multiple or single tools . . . for indexing and locating . . . for clamping, etc., all or any of the movements and in any combination, can be adapted to HYDRAULICS . . . Any designer or builder of machines can accommodate their specific design, either partially or completely to "HY-MAC" HYDRAULICS . . . and our modern plant, together with a comprehensive engineering department is completely competent to handle all of the technical planning, designing, and detailing in connection with building of hydraulic and specific-purpose machinery . . . Our engineers will be glad to make recommendation and preliminary proposal without obligation.

8444-Unit for actuating and controlling a simple feed circuit which incorporates rapid traverse, adjustable feed and rapid return of a single slide—primarily for drill press type of operation but can also be used for the control and actuation of a press or any machine where only one slide is to be controlled.

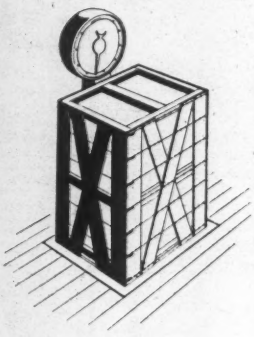
HYDRAULIC MACHINERY, INC.
12825 FORD ROAD • DEARBORN, MICHIGAN

HYDRAULIC MACHINERY

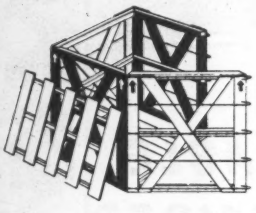
Ship it in a Wirebound and get all four...



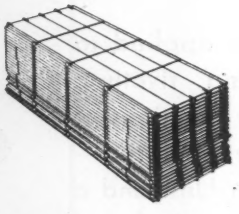
Strength...Wirebound Boxes and Crates are designed to take all of stresses, strains, shocks and stacking loads encountered in shipment and warehousing.



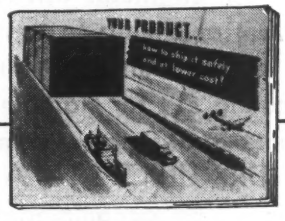
Lightweight...modern Wirebound Boxes and Crates add the strength of steel to lighter construction to assure maximum product protection.



Ease of Assembly...Wirebound Boxes and Crates come to you at least two-thirds assembled, and most sizes can be made-up, ready to pack *in less than a minute!*



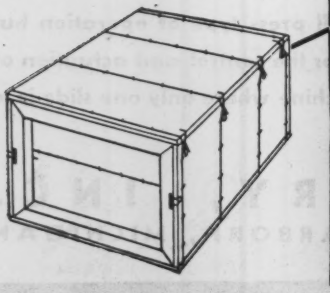
Save Shipping Room Space... Wirebound Box and Crate mats store flat and may be assembled in but a few moments *as needed!*



Send today for your free copy of this 24-page book, "YOUR PRODUCT... How to ship it safely and at lower cost." Here are a few of the important points covered...

- how to reduce shipping charges with a Wirebound that safely eliminates excessive weight!
- gain greater strength, eliminating costly loss and damage claims!
- saves 50% or more time in assembling and closing!
- save valuable space in your shipping department!

Wirebound Box Manufacturers Association, Room 1823, Borland Building, Chicago 3, Ill.



Wirebound BOXES & CRATES

Cams

—ANOTHER TYPE OF PART ESPECIALLY SUITED TO PRODUCTION IN

POWDERED METAL

How Many Operations?

By conventional methods, how many operations do *you* think would be required in producing this cam?

In our plant it is shaped, complete to final dimensions, in one operation!

So you can readily see the advantage of powder metallurgy, from the production standpoint alone. Other advantages not so obvious from the illustration, but just as real, are:

Controlled precision to extremely close tolerances, even on long runs.

Controlled ductility, hardness, porosity, to meet highly specialized requirements.

Special alloys and mixtures of metals or metallic and non-metallic substances, not obtainable otherwise.

Many post-war products now on drawing boards will be more efficient in performance, more economical in production, because of the cooperation of our engineers and production technicians. Why not let these specialists in powder metallurgy help *you* obtain similar results in *your* product? Give us an idea of the shape, size and function of the part; we'll soon tell you whether it can—or *should* be made in powdered metal, and work out a schedule of deliveries to fit in with your requirements. Write us today!

PMP

POWDERED METAL PRODUCTS CORPORATION

1800 W. BERENICE AVENUE, CHICAGO 13, ILLINOIS

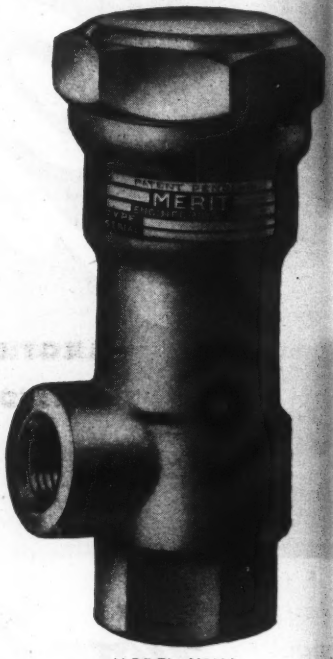
Designed for Smoother Hydraulic Power

MERIT

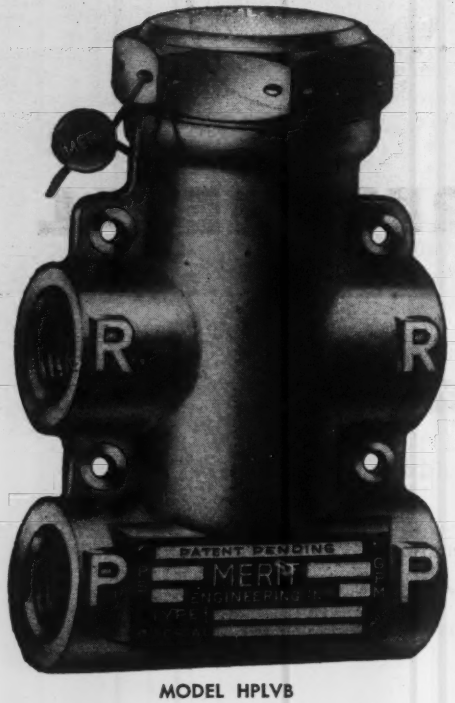
Hydraulic Relief Valve

Patent Pending
Illustrations
2/3 Actual Size

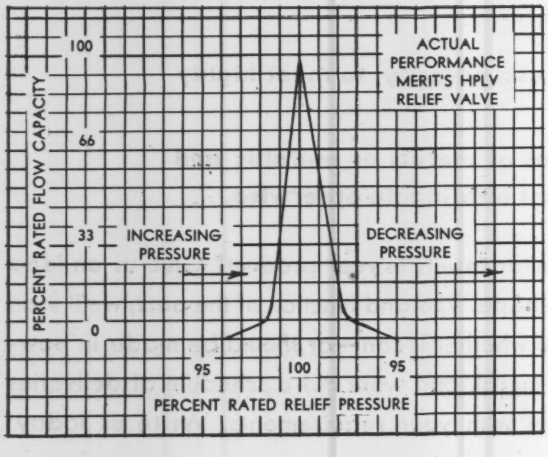
CARTRIDGE



MODEL HPLV



MODEL HPLVB



Precision Operation
Positive Finger Tip Control

The valve is simple in design and consequently free from most operational and maintenance problems. It is offered in aircraft and industrial housings, with interchangeable cartridge. This valve, with three sets of springs, covers a pressure range of 100 to 3200 psi, with maximum flow from 6 gpm to 35 gpm. It operates smoothly, opening and closing within 7%, and is chatterless. The valve has been tested over a long period of time and has performed satisfactorily above the listed pressures. Model HPLVB conforms to Army-Navy Specification AN6200.

The cartridge may be purchased separately for building into machine tools, pumps or other hydraulic equipment. We welcome your inquiries on valve problems and suggest that you specify port connections, fluid to be used, temperature limits, pressure range, rate of flow, type of application and any other pertinent information.

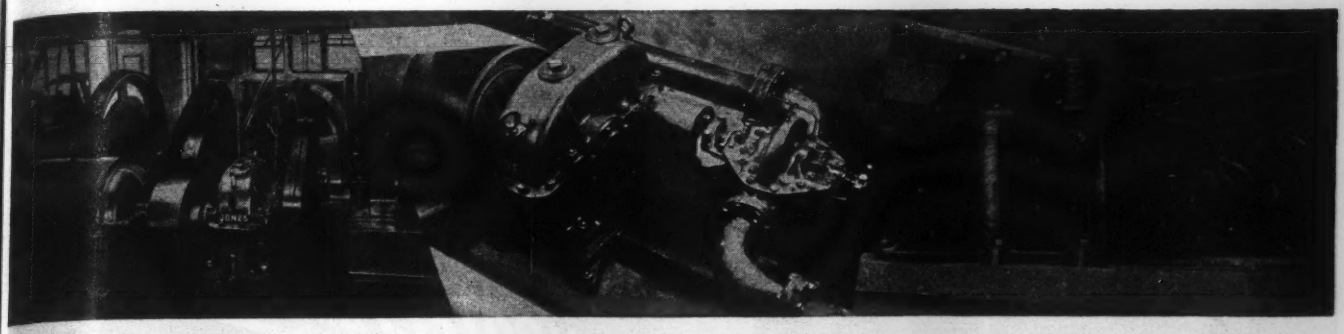
Recommended limits for hydraulic oil with viscosity approximating SAE-10 are as follows:

MODEL HPLV

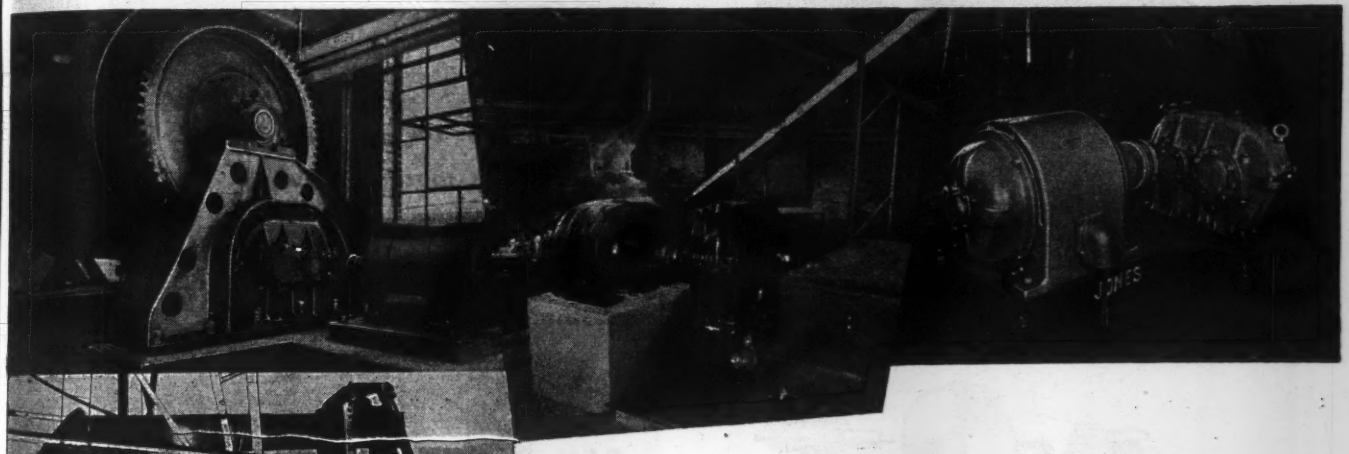
SPRINGS	MINIMUM PRESSURE	MAX. FLOW AT MIN. PRESSURE	MAXIMUM PRESSURE	MAX. FLOW AT MAX. PRESSURE
A-3	100 psi	6 gpm	750 psi	16 gpm
B-3	375	11	2400	30
C-3	500	13	3200	35

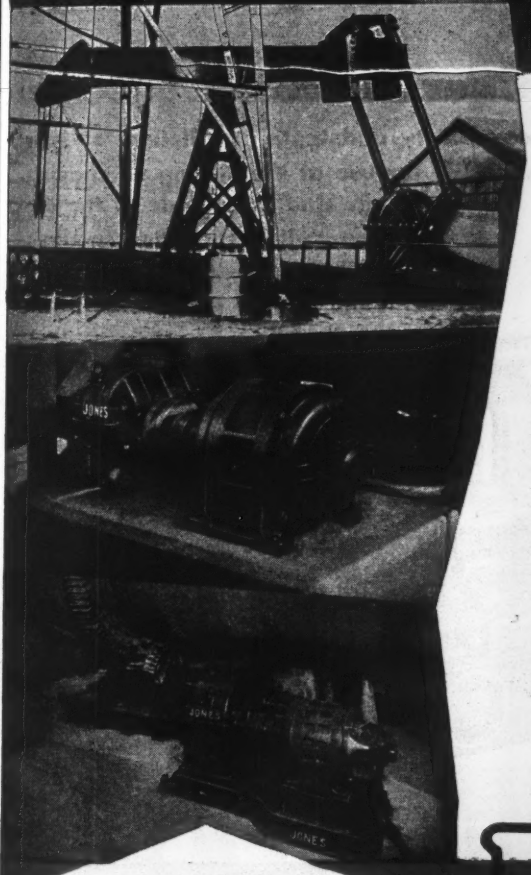
MERIT ENGINEERING INC.

40 CLIFFORD STREET PROVIDENCE 1, R. I.



JONES DRIVES FOR INDUSTRY





★ For many years the W. A. Jones Foundry & Machine Company has been called upon as a consultant, to help solve a great variety of difficult drives involving the use of speed reducers, gears and other transmission machinery. In many cases these installations have called for the development of special equipment, designed and built to suit the specific requirements of the project.

As a result of these years of experience, involving numerous special problems in the mechanical transmission of power, the Jones organization has collected a vast amount of technical data relating to work in various fields.

Specific bulletins and catalogs are available on the products listed below and a general 20 page bulletin "Jones Drives for Industry" presents a broad picture of Jones products, engineering services and manufacturing facilities.

W. A. JONES FOUNDRY & MACHINE CO.
4413 Roosevelt Road, Chicago 24, Illinois

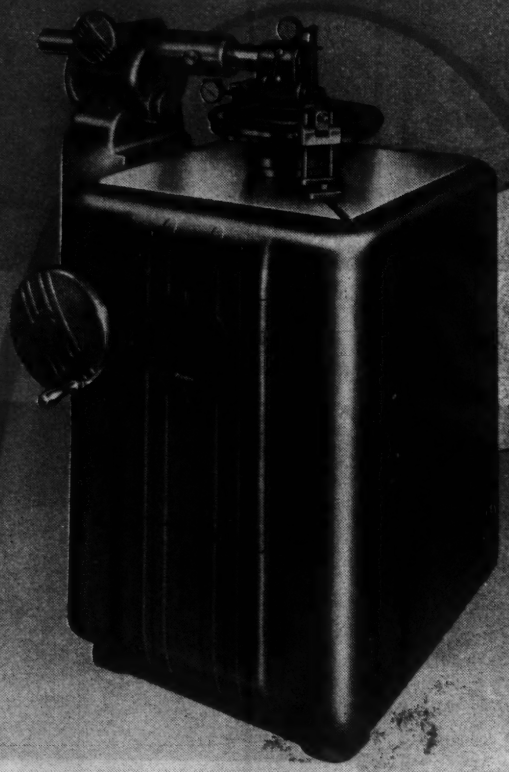
JUST ASK FOR BULLETIN NO. 80 ➡

● These illustrations show application of Jones drives to solve a wide range of industrial power transmission problems.

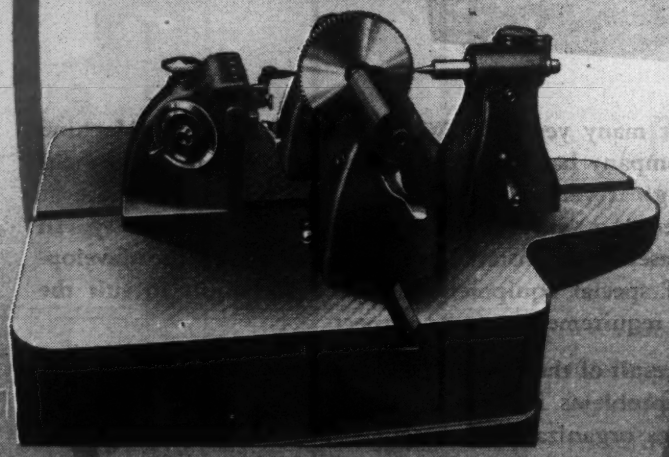
Jones

HERRINGBONE—WORM—SPUR—GEAR SPEED REDUCERS ● CUT AND MOLDED TOOTH GEARS ● PULLEYS
ANTI-FRICTION PILLOW BLOCKS ● V-BELT SHEAVES ● FRICTION CLUTCHES ● TRANSMISSION APPLIANCES

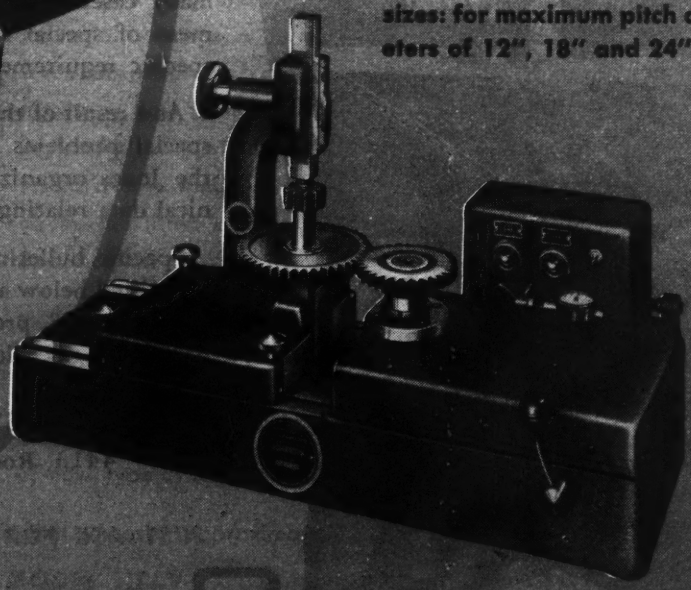
CHECK GEAR ERRORS *ACCURATELY and QUICKLY*



RED RING INTERNAL GEAR CHECKER
Checks tooth spacing, eccentricity, pitch diameter and root diameter of internal spur or helical gears from 2 to 48 diametrical pitch and from 2" to 18" P.D. With auxiliary head, it will also check parallelism of internal spur gear teeth.



RED RING SPUR GEAR CHECKER
Checks eccentricity and tooth parallelism of spur gears especially for use at the cutting or shaving machine as a guide to the operator. It is furnished in three sizes: for maximum pitch diameters of 12", 18" and 24".



RED RING GEAR ROLLING FIXTURE. The work gear may be tested in mesh with its mating gear or with a master mating gear. Any deviation or error in the work gear is shown instantly on an indicator which is an integral part of the fixture. Various attachments can be furnished to suit the gear mounting.

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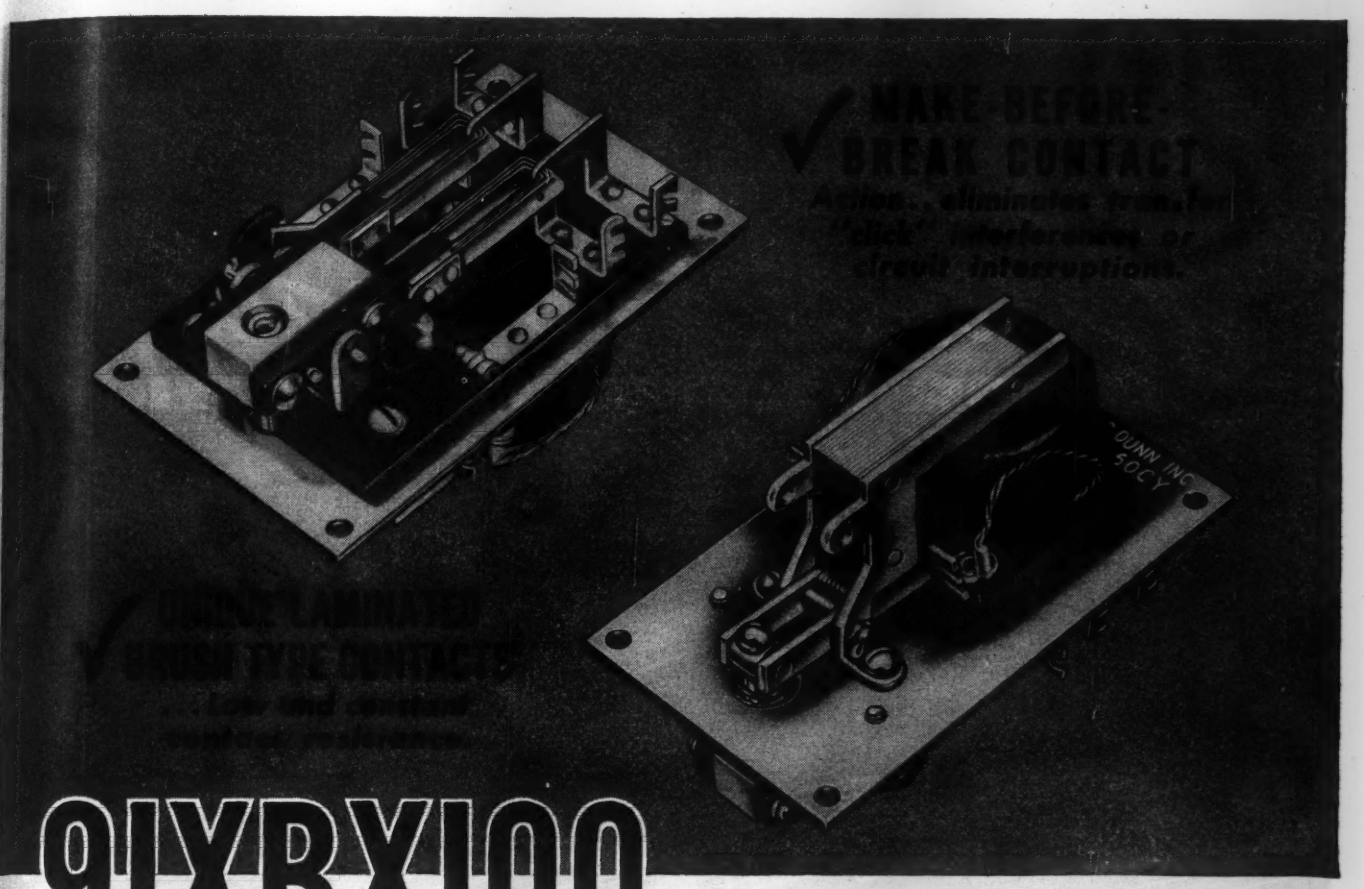
5600 ST. JEAN • DETROIT 13, MICH.
SPECIALISTS IN SPUR AND HELICAL INVOLUTE GEAR PRACTICE
ORIGINATORS OF ROTARY SHAVING AND ELLIPTOID TOOTH FORMS

RED RING PRODUCTS



91XBX100 ..... DESIGNED FOR MICROPHONE AND THERMO-COUPLE SWITCHING CIRCUITS...

and other extremely low power control applications

The Struthers-Dunn a-c operated Type 91XBX100 Relay has double-pole double-throw, make-before-break contacts that are especially designed for handling milli-volt, milli-ampere, and milli-watt loads. Each moving contact consists of six laminations. The long sliding motion of the six contact surfaces results in extremely low and constant contact resistance, thus assuring electrically smooth performance—a "must" in audio frequency or recording instrument switching circuits.

The metal mounting plate acts as a shield, isolating the magnetic structure from the contacts, minimizing the possibility of induced a-c hum in the contact circuits.

Operating coils are available for use on standard voltages up to 230 volts a-c, 60 cycles.

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STRUTHERS-DUNN, Inc., 1321 Arch Street, Philadelphia 7, Pa.

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5,312 RELAY TYPES

AUTOMATIC *Grooving Tools* FOR HIGHER PRODUCTION

You can groove faster, more accurately and economically with a Scully-Jones recessing tool. These automatic tools are suitable for production work on Turret Lathes, Automatic Screw Machines, Drill Presses or Horizontal Boring Mills for grooving, undercutting, recessing, necking and facing.

Adjustment is provided for the tool bit after grinding as well as location of groove and correct depth setting to control the diameter of recess.

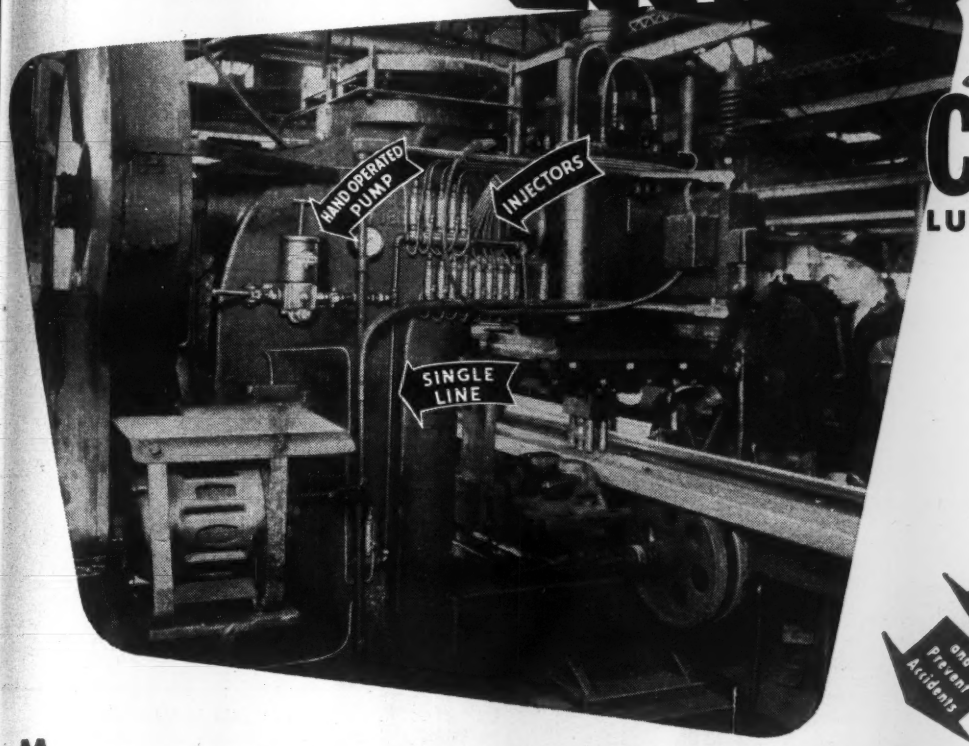
Send us blueprint or sketch of your recessing problem for a quotation.

Scully-Jones AND COMPANY

1901 SOUTH ROCKWELL STREET • CHICAGO 8, U. S. A.

"Down Time" is Lost Time!..

Install LINCOLN Single Line CENTRO-MATIC LUBRICATING SYSTEMS and save



Machine "down time" results in increased production costs—Today's accelerated production has brought out the inadequacies of older, time consuming methods of lubrication—has proved the importance of Centro-Matic centralized lubricating systems for reducing "down time"—saving power—preventing accidents.

Lincoln Centro-Matic Systems help keep machines on the job — and have shown their dependability in many war-time operations of importance—These systems have inherent features of design that are the answer to many troublesome lubrication problems — check the advantages listed below:

1—Dispense either oil or grease.

2—Deliver a pre-determined measured quantity of lubricant to each bearing.

3—Lubricant delivered at a uniform pressure even to remote bearings.

4—Injectors are easily adjusted for the desired output—no special tools needed.

5—Each injector has external indicator.

6—Complete range of lubricant pumps ——pneumatically, electrically or manually operated.

7—Will pump lubricant from original container at fixed time intervals.

8—All pumping units are of proven design.

9—One pump can supply one machine or a battery of machines.

10—Easy to install. Only one supply line needed.

11—Injectors in manifold can be removed singly without disturbing other injectors.

12—Linpak packing —no metal-to-metal seals.

13—A product of a company that manufactures lubricating equipment exclusively.

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Engineering Service

Lincoln Engineering Company maintains a staff of experienced lubrication engineers prepared to assist you in all lubrication problems. Write us, enclosing a blueprint or specifications of the machine you wish to lubricate and we will make a recommendation as to the type of Centro-Matic System best suited to do the job.

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Pioneer Builders of Engineered Lubricating Equipment

Just to Remind You...

FULL CAPACITY

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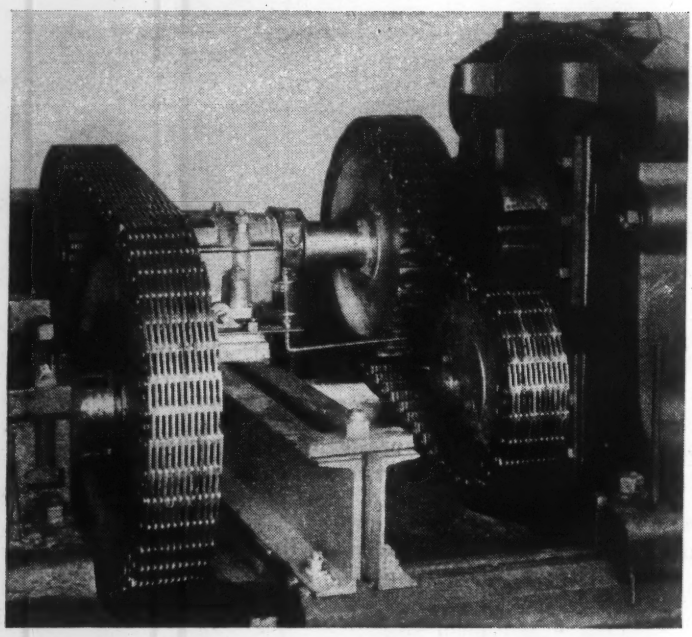


EASY TO MAINTAIN

WIDE RANGE OF SIZES AVAILABLE

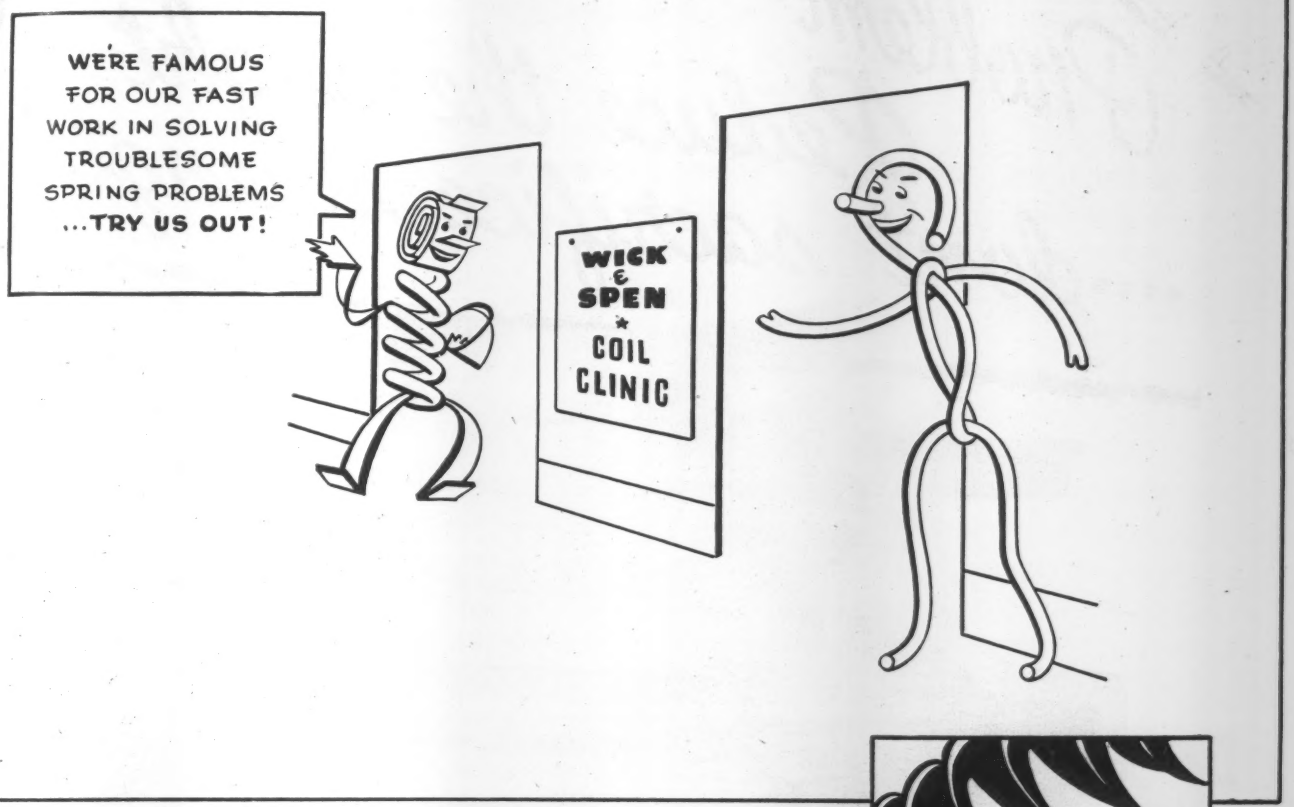
Countless applications in a multitude of industries have proved Morse roller and silent chain efficiency. A wide range of sizes is available. Each in its field has demonstrated that the Morse principle of teeth, not tension, turning chain-driven shafts, means maximum, uniform power transmission at low cost. Talk over your power transmission needs with your Morse engineer. MORSE CHAIN COMPANY, Ithaca, N. Y., Detroit, Mich., Division Borg-Warner Corporation.

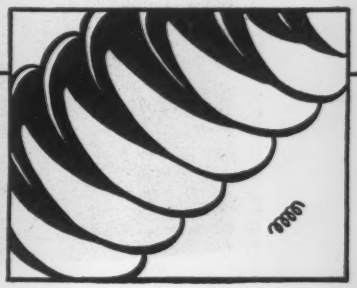
UNAFFECTED BY ATMOSPHERIC CONDITIONS

SPROCKETS CHAINS FLEXIBLE COUPLINGS CLUTCHES

MORSE Roller and Silent CHAINS

MORSE CHAIN COMPANY • ITHACA, N.Y. • DETROIT 8, MICH. • A BORG-WARNER INDUSTRY





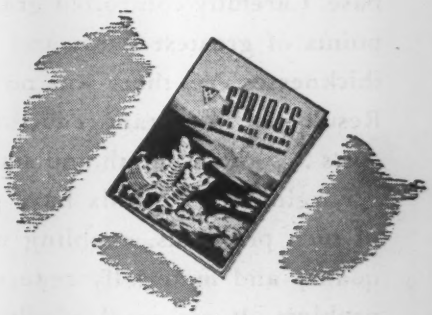
NO JOB TOO BIG . . . NO JOB TOO SMALL!

For Wick and Spen, there's no such thing as a spring or coil problem that *can't* be cured. They take on new and different jobs every day—especially now, with post-war products in the planning stage on thousands of drawing-boards. Their "know how" comes from years of experience—no job has *ever* been too big, nor too small!

Every problem that comes to us undergoes a thorough checkup. We like to start at the beginning, and check and double-check every factor of design and requirement. Then, we establish the formula for the steel (for your particular spring); make it in our own open hearths; draw, form, temper and test it in our own mills. No factor is overlooked in our efforts to serve you.

Send for a copy of our free book "Springs and Wire Forms." It gives data relating to spring performance, including formulae, tables and other technical information needed in proper spring selection. Address Wickwire Spencer Steel Company, New Bond Street, Worcester 6, Massachusetts.

It takes an entire coil of wire to form the largest spring we make—such springs are used on the huge overhead doors in aircraft hangars. This same coil of wire will produce 8,000,000 of the smallest springs we make—tiny springs that go into delicate recording instruments.

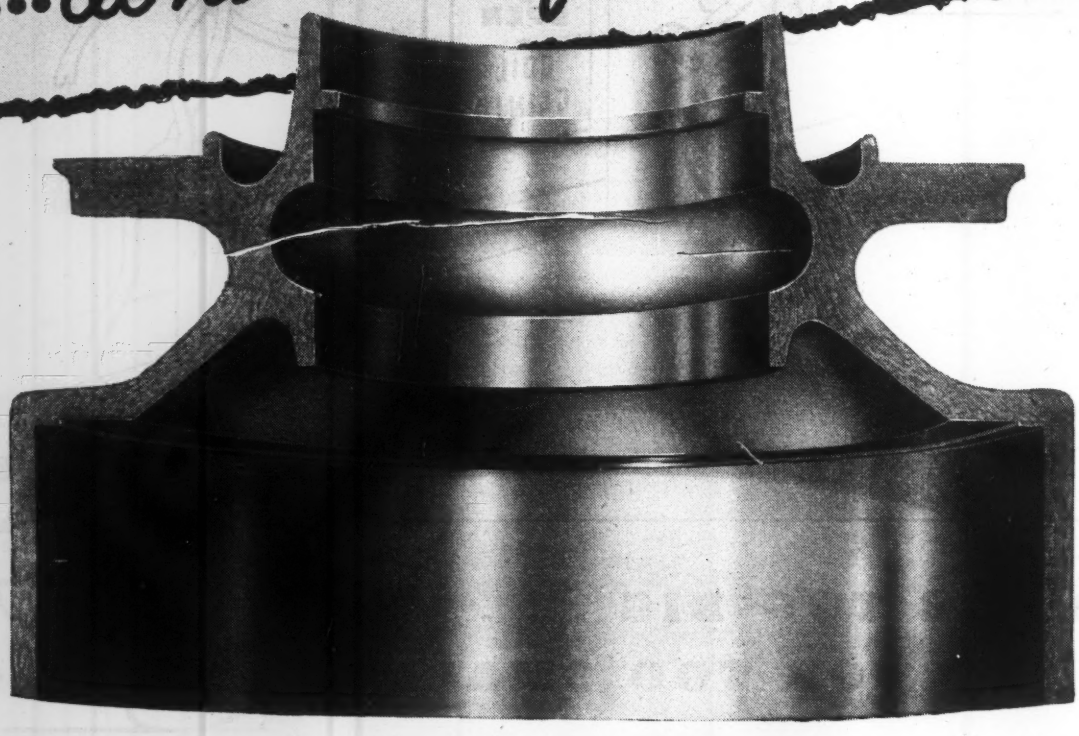


WICKWIRE SPENCER Steel Company

EXECUTIVE OFFICES—500 FIFTH AVENUE, NEW YORK (18), N. Y.

Abilene (Tex.) • Boston • Buffalo • Chattanooga • Chicago • Clinton (Mass.) • Detroit • Houston • Los Angeles • Philadelphia • San Francisco • Tulsa • Worcester

Problem— Reduce the weight ....don't sacrifice strength



Solution: FORGINGS by PHOENIX

Here again is an illustration of the unusual advantages provided by the drop-forging process. This time it's an airplane starter base. Carefully controlled grain flow affording extra strength at points of greatest stress and strain made possible lighter wall thicknesses. Yet there was no sacrifice of rugged dependability. Result—an important reduction in weight . . . lower machining costs . . . and strength and stamina to spare.

Photomicrograph of an airplane starter base showing lines of flow produced by drop forging

Forgings by Phoenix have provided the solution to hundreds of such problems, enabling manufacturers to improve product quality and materially reduce costs. Perhaps you have such a problem. If so, we'll gladly discuss it with you . . . without obligation.

Forging Division of

PHOENIX MANUFACTURING COMPANY

CATASAUQUA PENNSYLVANIA

Forgings by **PHOENIX**

HERE'S THE *INSIDE STORY* OF THE

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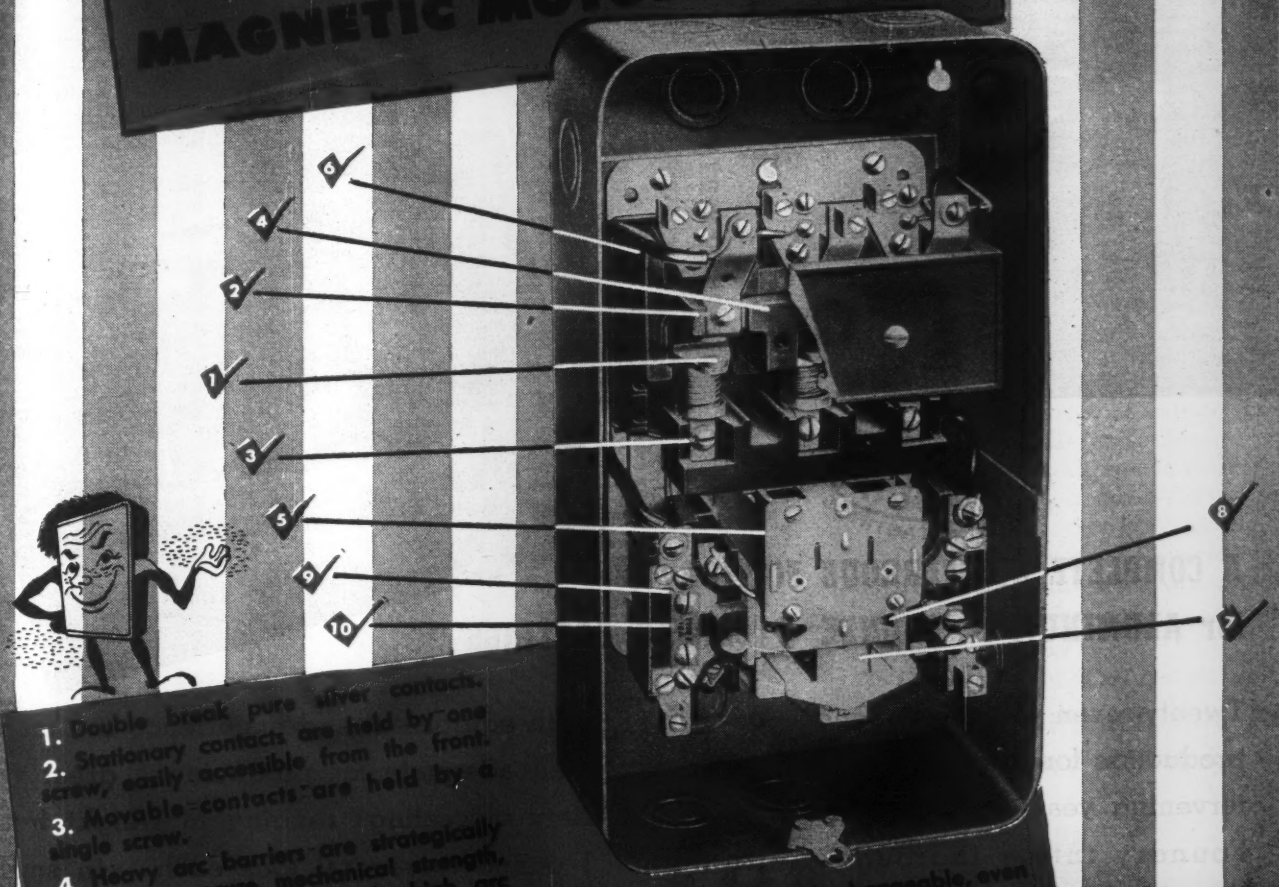
NOARK

MAGNETIC MOTOR STARTER



1. Double break pure silver contacts.
2. Stationary contacts are held by one screw, easily accessible from the front.
3. Movable contacts are held by a single screw.
4. Heavy arc barriers are strategically located to secure mechanical strength, resist flashover, and provide high arc rupturing ability.
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6. All molded parts located near the contacts are asbestos base with a non-carbonizing inorganic binder.
7. Straight line vertical ball bearing action.
8. The coils are readily changeable, even in the cabinet. Pull out the retainer spring, loosen yoke and take out the magnet, and the coil is free.
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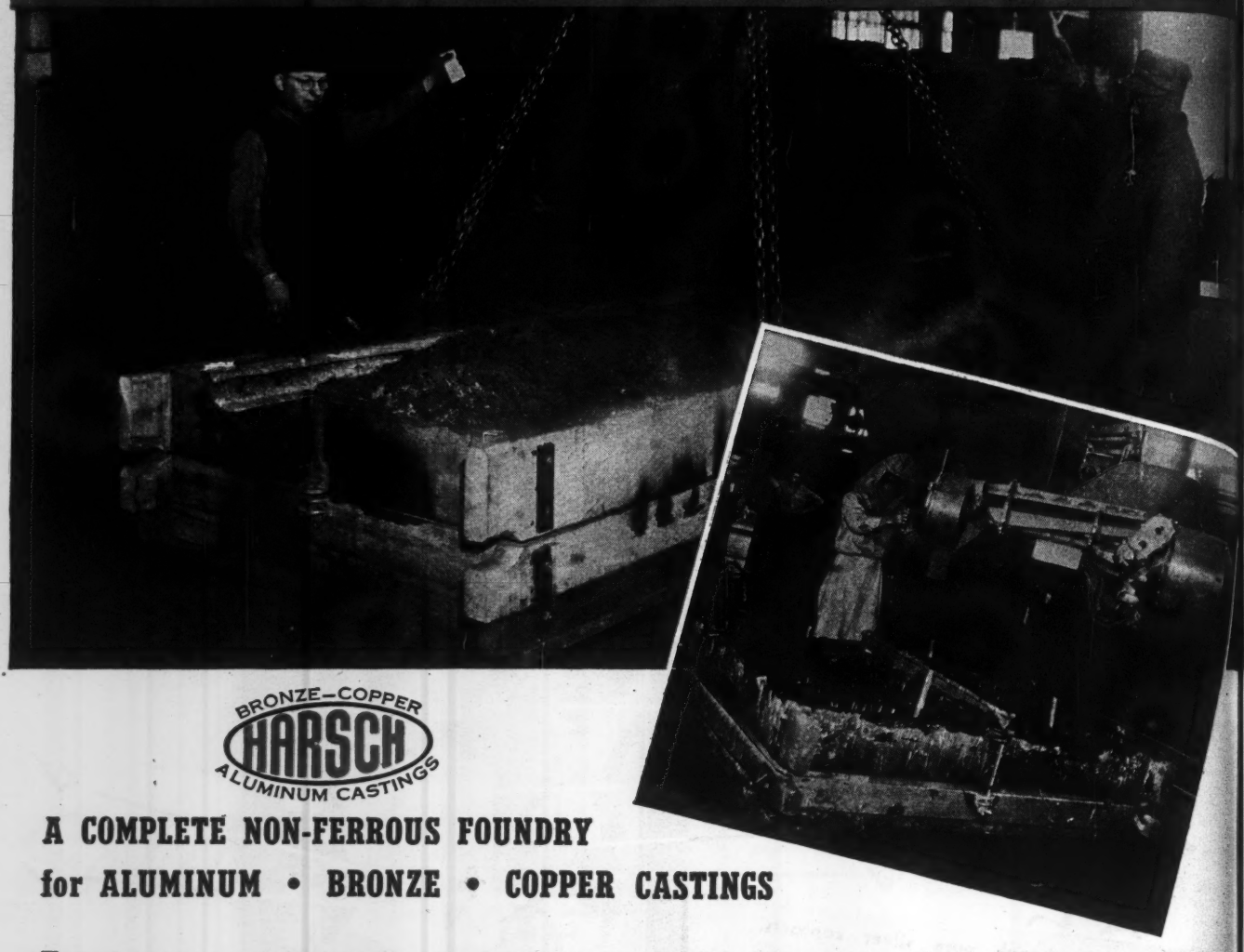
HARSCH HAS EQUIPMENT—

FOR MAKING LARGEST CASTINGS



BRONZE—COPPER HARSCH ALUMINUM CASTINGS

A COMPLETE NON-FERROUS FOUNDRY
for ALUMINUM • BRONZE • COPPER CASTINGS

Twenty-seven years experience—covering production for two wars as well as the intervening years — have built the Harsch Foundry into a thoroughly efficient, smoothly operating plant. Precision, labor saving equipment is used to speed production and turn out highest quality castings.

Both equipment and experience are more than adequate for producing a great variety of castings ranging in weight from 1 ounce to several tons each — in small lots or on a large production basis.

Why not select Harsch as your chief source of non-ferrous castings?

The JOHN HARSCH BRONZE and FOUNDRY Co.

Sales Offices: New York, Chicago, Detroit, St. Louis, Pittsburgh, Akron

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ALUMINUM PERMANENT MOLD CASTINGS

OHMITE *Rheostats*

INSURE PERMANENTLY SMOOTH

CLOSE CONTROL

10 Wattage Sizes

. . . in a variety of types to meet every need

There's an Ohmite Rheostat to assure the best unit for each control need . . . from the 1000 watt, 12″ diameter, Model "U" to the 25 watt, 1 9/16″ diameter, Model "H". Made in single or tandem units, with uniform or tapered windings, in stock or special resistance values. And large or small—each Ohmite Rheostat is designed to give smooth, close control—long life—and trouble-free service. In Resistance Control, Ohmite Experience Makes a Difference.

Write on company letterhead for Catalog and Engineering Manual No. 40.

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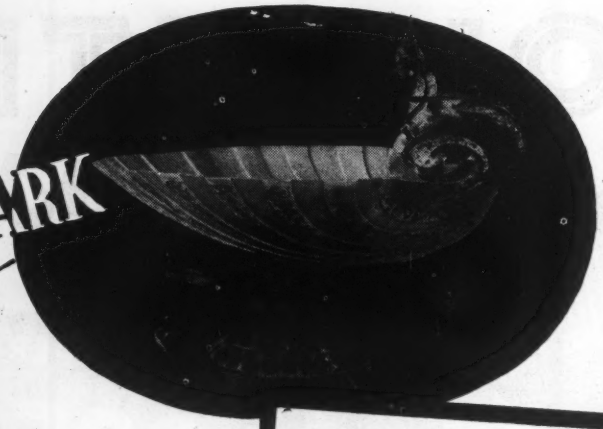
Be Right with OHMITE

RHEOSTATS • RESISTORS • TAP SWITCHES

Like the CELLINI HALLMARK *on fine Metalcraft*



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INDIVIDUALIZED EQUIPMENT PARTS

Since 1881

The name Cellini represents outstanding workmanship to the fine arts... just as the name KOVEN represents outstanding workmanship and quality to industry.

Through the years, manufacturers have found that KOVEN can build a part or parts of their finished product faster, more efficiently and more economically than these parts can be built within their own plants. KOVEN has been designing and manufacturing individualized equipment parts, made to exact specification, for over 64 years. Their knowledge resulting from these years of experience is available to you through a consultation with a KOVEN representative. This service will not obligate you. Call or write KOVEN.

Illustrated—ink cooling tank, made for a manufacturer of printing presses; manifold and welded gear case made for manufacturers of Diesel Engines.

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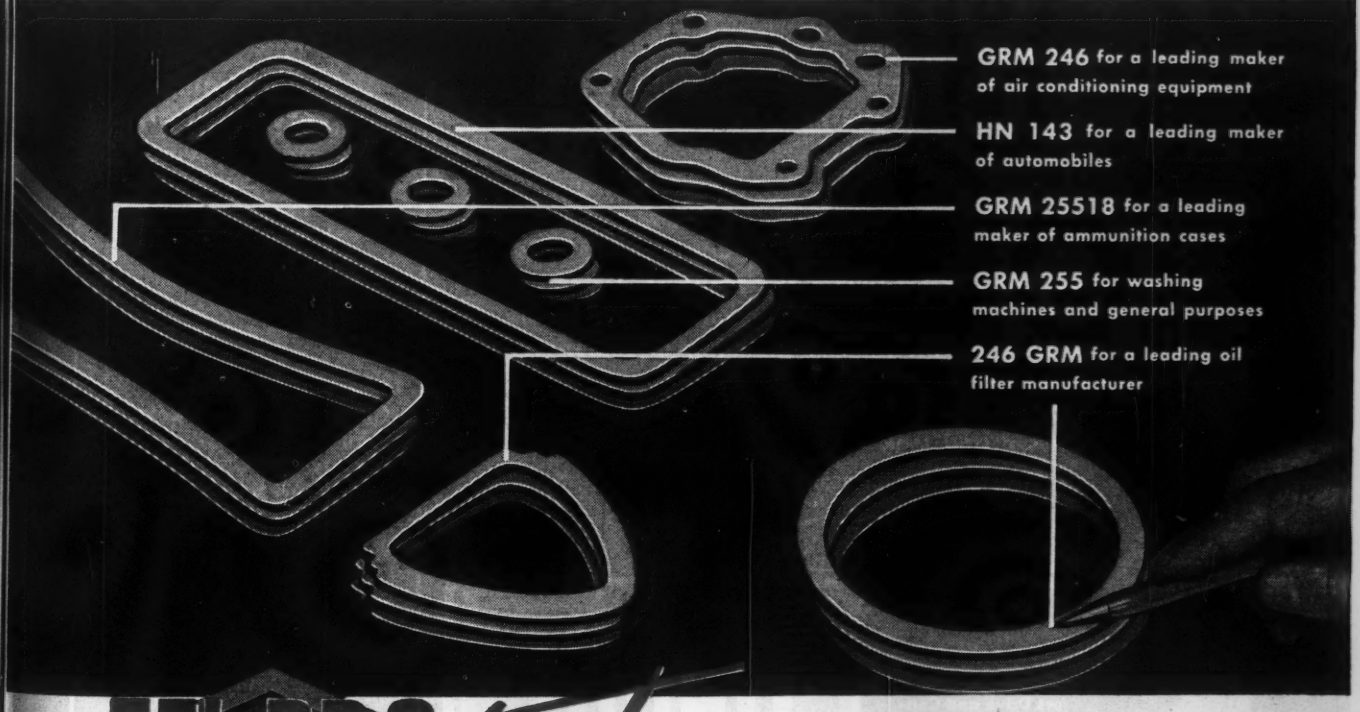

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NAME .....

1199 ATTACH THIS TO YOUR LETTERHEAD →

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Another Note On Specialization

☆ While many musicians are accomplished on more than one instrument, the great virtuoso invariably has a lifetime of study and practice behind his mastery of only one medium of expressing his musical genius.

The opportunities for offering exceptional service to industry are such that here, too, specialization is often productive of a superior result. For example our Union Chain organization finds sufficient challenge and interest within the limits of designing and manufacturing a complete line of steel chains for the transmission of power and the mechanical handling of materials. Some chain users find that this specialization makes a difference, both in product and service. Call a Union representative on your next chain requirement and look for a new note in the result.

The Union Chain and Manufacturing Company, Sandusky, Ohio, U. S. A.

Union Chains for Every Application

Drive and Conveying Chains and Sprockets
- Bridge Chain
- Combination Malleable Iron and Steel Chain
- HB (hardened bearing) type chain
- BP (bar and pin) type chain

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Finished Steel Roller Chains and Sprockets
- All manufacturer's standard, size $\frac{3}{8}$ in. to $2\frac{1}{2}$ in. pitch
- Single and Multiple Strands
- Extended Pitch Series in sizes $1\frac{1}{4}$ in. to 4 in. pitch

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Silent Chain and Sprockets
- All sizes $\frac{3}{8}$ in. to $1\frac{1}{2}$ in. pitch

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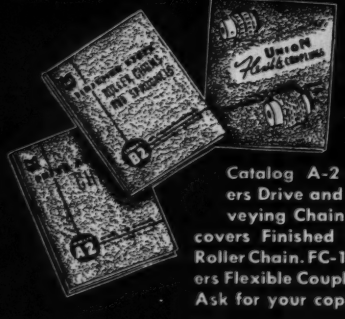
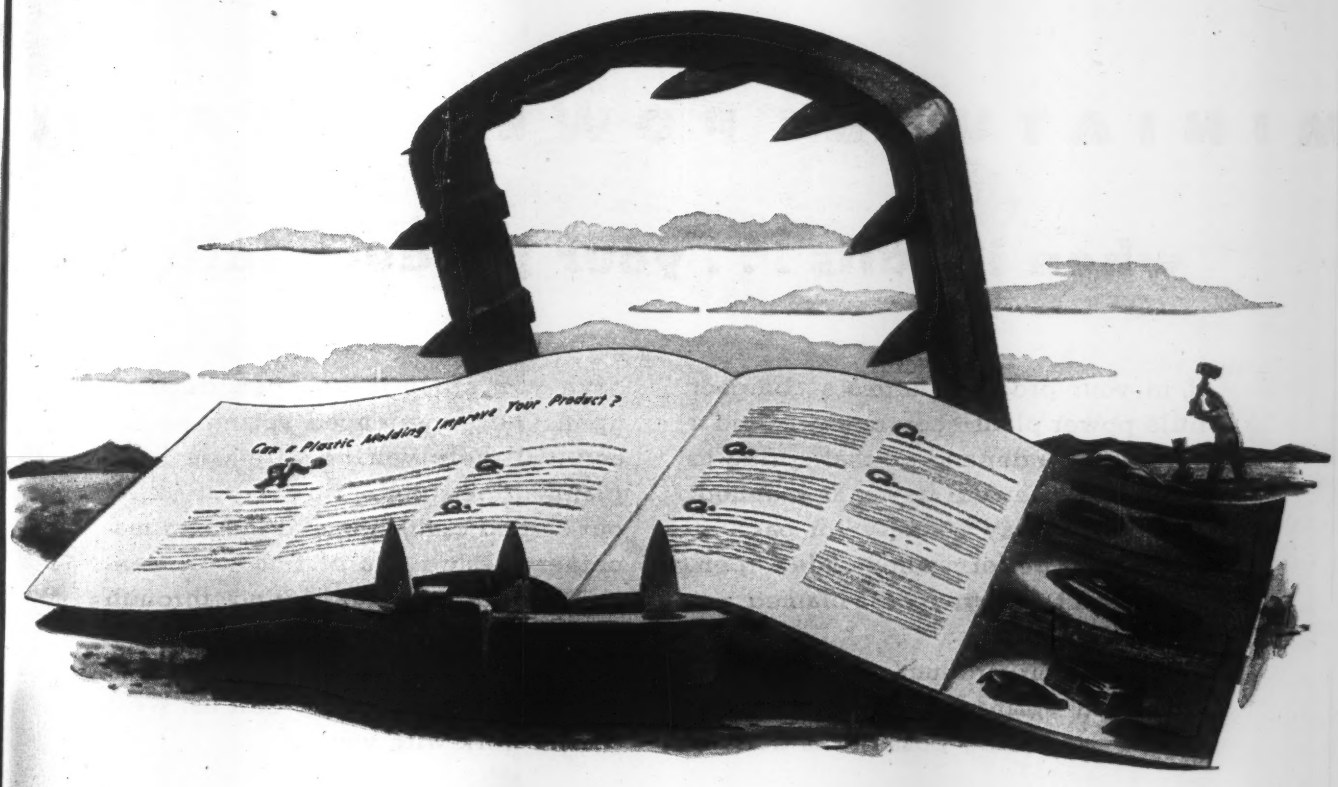
Flexible Couplings
- Roller chain type
- Silent chain type



Catalog A-2 covers Drive and Conveying Chain. B-2 covers Finished Steel Roller Chain. FC-1 covers Flexible Couplings. Ask for your copies.

ARMY E NAVY

UNION CHAINS



Free Offer!...with a (small) Catch to it!

IF YOU ARE A BUSINESSMAN with a yen to know more about plastics, you'll want your free copy of this illustrated booklet. It tells what plastics will do. It even tells what they won't do. It tells how to go about getting complete data on your project. It goes on to describe production functions from design through the finishing stages—and how to make use of them.

As for the designer, the design engineer and the professional purchaser—men who know plastics from living with 'em—there's something here for you, too. Not technical data on design or materials—which would only get the once-over-lightly treatment in a booklet like this anyway. We mean information on the kind of thinking and equipment offered by a long-established but progressive molder who would like consideration as your source of supply.

The catch? Well, after you've read it, you may want Kurz-Kasch to figure a job for you. Is that bad? We can name plenty of manufacturers who don't think so. Fill in the coupon and attach it to your letterhead. Get a free copy of "A Businessman's Guide to the Molding of Plastics"—and test *your* will power!

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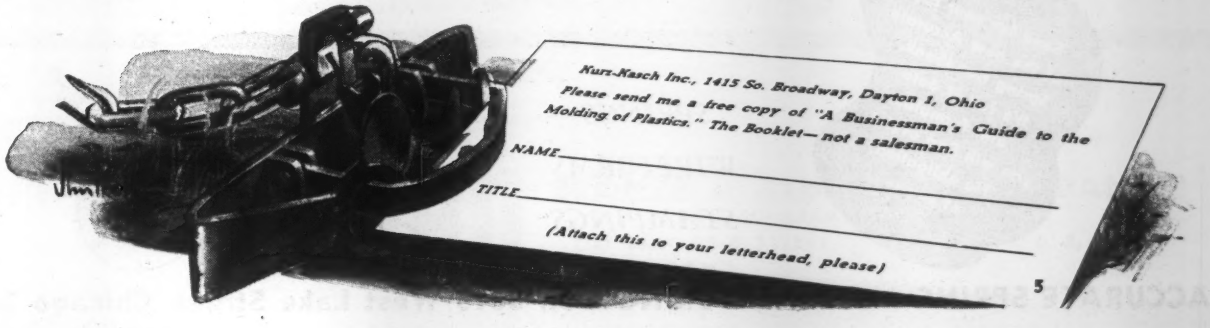

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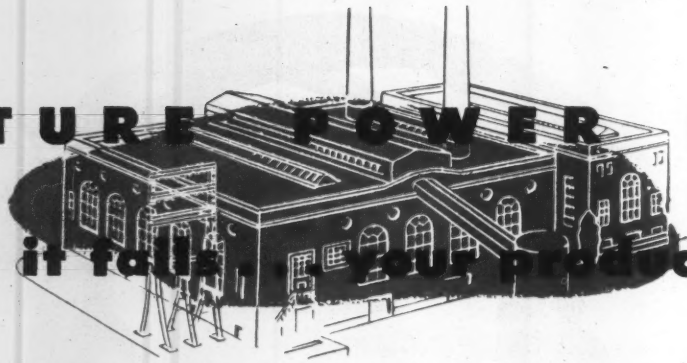
(Attach this to your letterhead, please)

5

MINIATURE POWER PLANT



when it fails, your product fails

If, in your product there's a compact little power plant—commonly called a spring—you depend on that spring to deliver mechanical power as planned. Its function may be active or passive, but it *must* perform when called upon. If it doesn't, the *product* is blamed, *not* the spring.

Insure your product's good reputation with springs from Accurate . . . where everything possible is done to give you springs you can depend upon. Our experienced spring engineers will help you be sure you have planned the right spring for the job... our skilled craftsmen and modern machinery assure you of fine workmanship . . . and, careful testing through critical stages of manufacture will give you springs that you can rely on to function well and long. Call us. We'd like to work with you.

Accurate—
for springs
that won't
let your
product down

Send for your copy of the new Accurate Spring Handbook. It's full of data and formulae you will find useful. No obligation, of course.

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Accurate Springs

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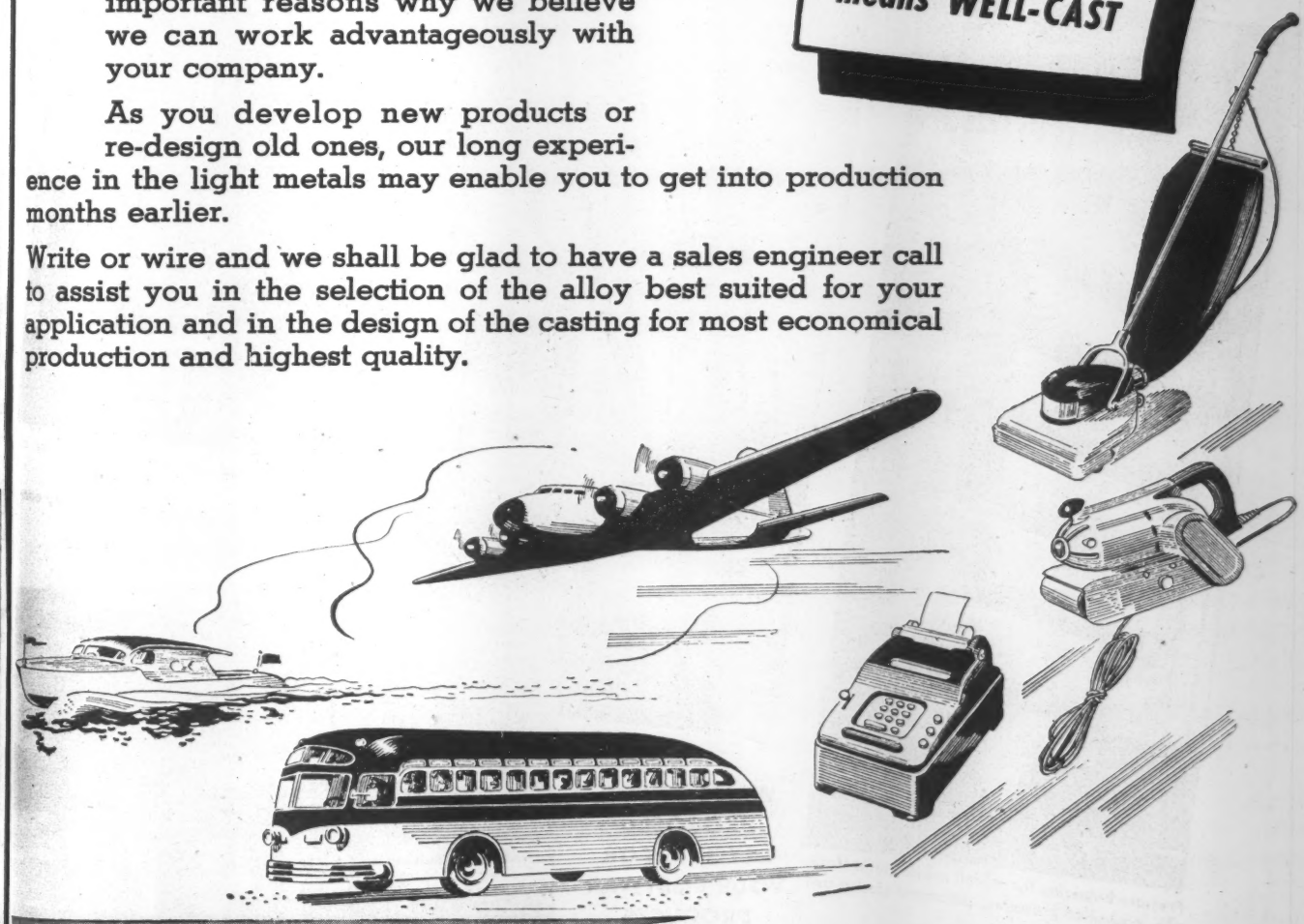
MAGNESIUM
BRONZE
AMPCO BRONZE
BRASS
Patterns in
METAL OR WOOD
WELLMAN
means WELL-CAST

• Our 35 years' experience and modern laboratory, foundry, and pattern-shop facilities are among the important reasons why we believe we can work advantageously with your company.

As you develop new products or re-design old ones, our long experience in the light metals may enable you to get into production months earlier.

Write or wire and we shall be glad to have a sales engineer call to assist you in the selection of the alloy best suited for your application and in the design of the casting for most economical production and highest quality.



THE **WELLMAN** **BRONZE & ALUMINUM COMPANY**
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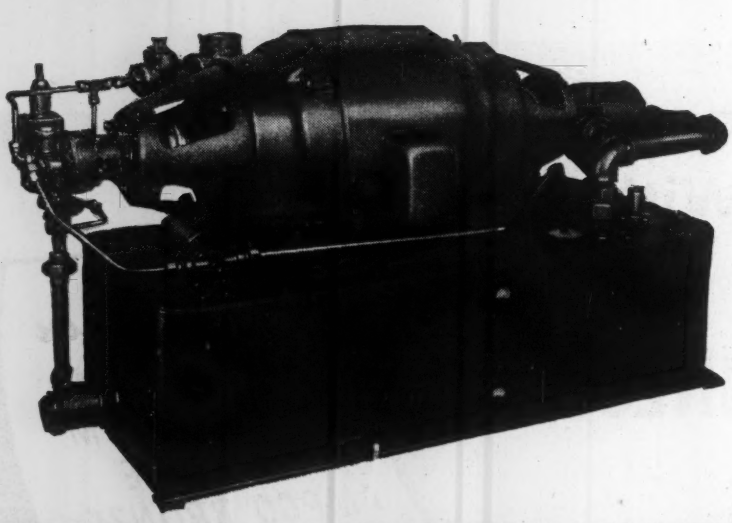

HYCON
Hydraulic Power

THE HEART OF THE MODERN MACHINE

Hydraulic Power Units are
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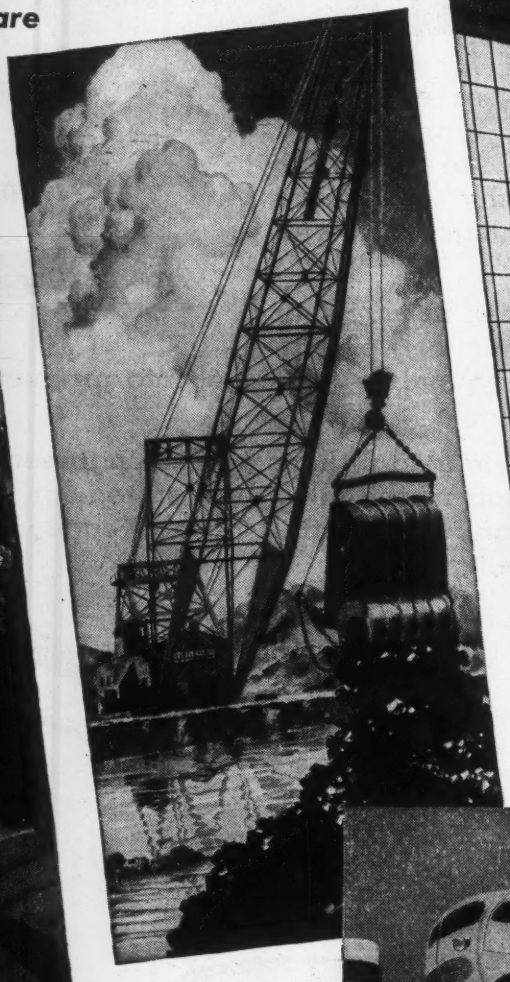
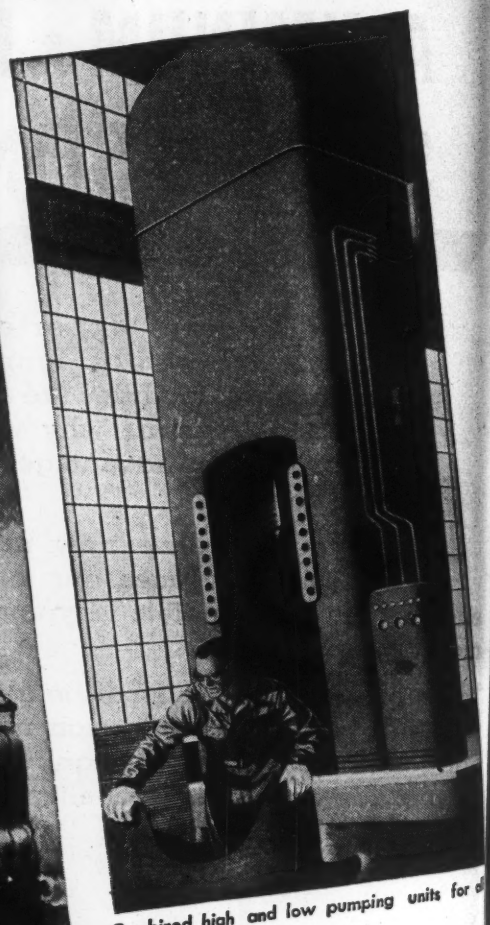
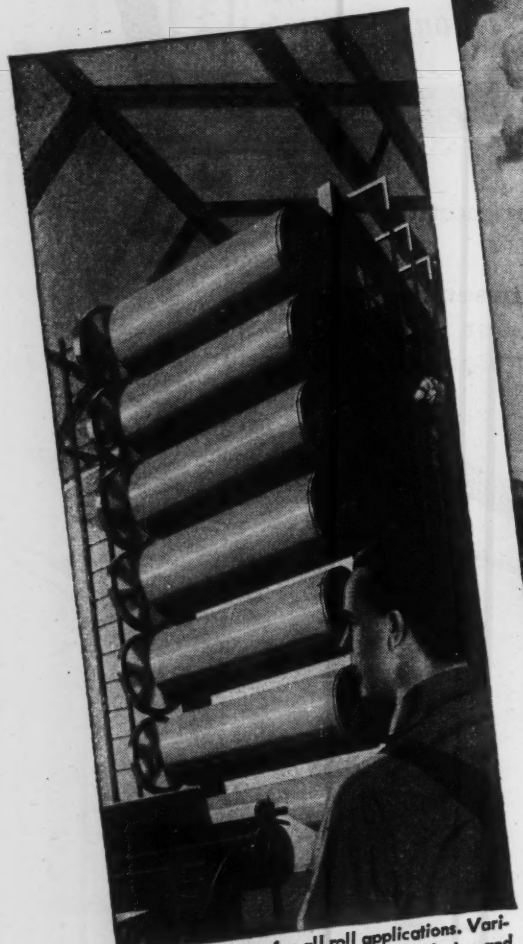
More Economical





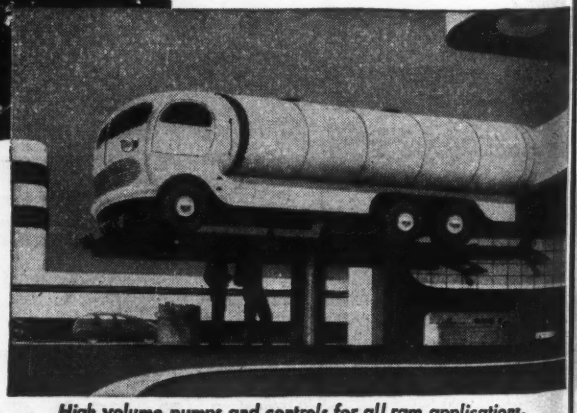
Combined high and low pumping units for all sizes and cycles.

At left: Brake and clutch control for heavy construction equipment.



Pressure balancing for all roll applications. Variable controlled pressures, automatic closing and release.

WRITE US FOR PROPOSED LAYOUTS FOR YOUR POSTWAR PRODUCTS



High volume pumps and controls for all ram applications.

THE NEW YORK AIR BRAKE COMPANY

Hydraulic Division

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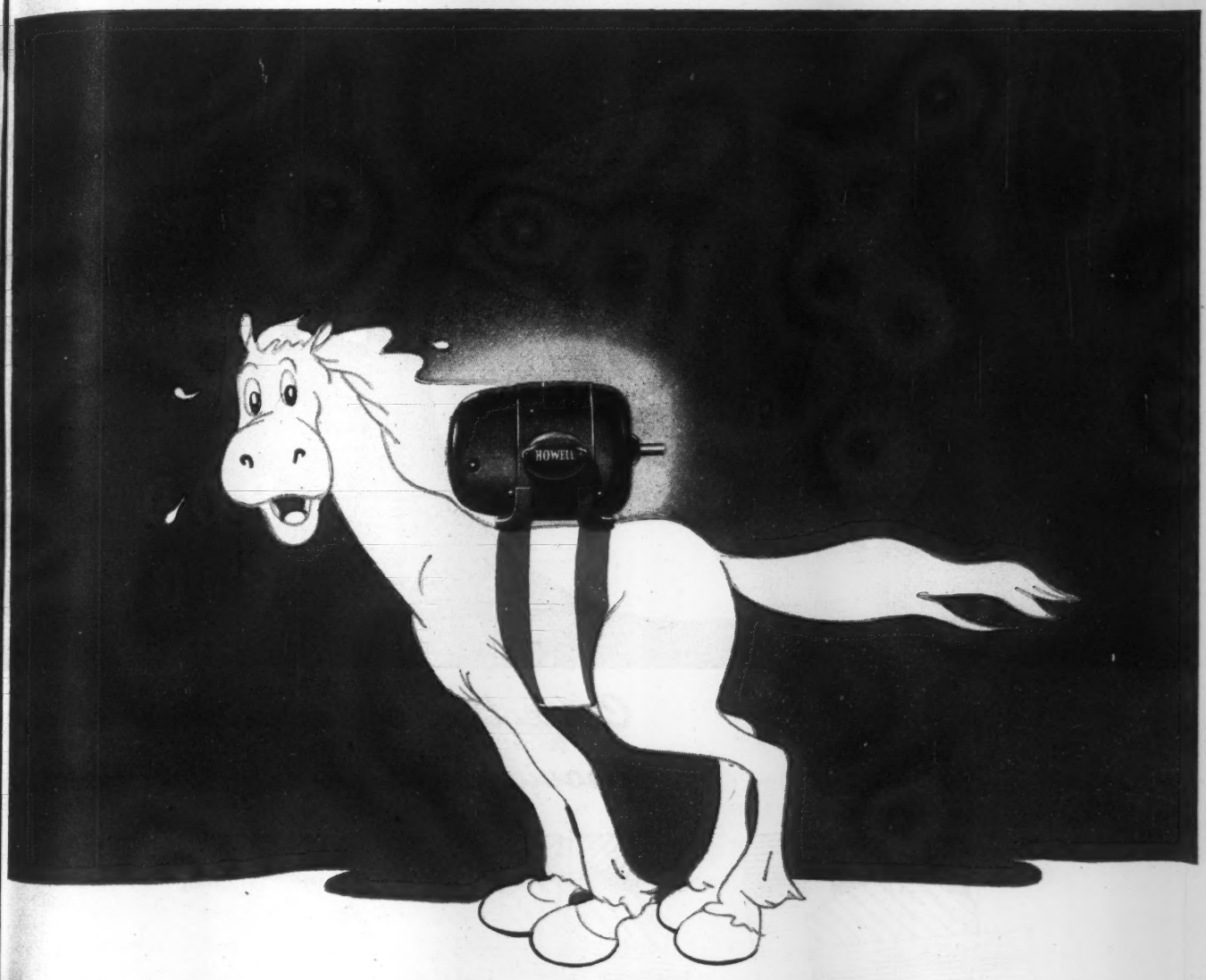


HERE'S WHY I'M RED BANDED!

The Howell Protected Type Motor, shown, gives complete protection against dripping liquids, metal chips and other falling particles. Completely streamlined—utilizing non-breakable steel frame—malleable or steel base—cast iron end plates and cast iron weatherproof terminal box are standard construction features. Special horizontal and vertical mountings are available. *Available in sizes 5 H.P. and smaller. Other sizes and types available up to 150 H.P.*

Years ago—1915 to be exact—we set out to build a line of motors to do specific jobs in industry.

These jobs were all what you would call "tough jobs." They were gruelling tasks which required the precision-building of higher-quality motors. They were jobs which demanded thorough insulation and sturdy construction.

We built our motors to meet the rigid requirements of just such jobs as these. To distinguish them from other makes, we put Red Bands on them. We constantly challenged buyers to give "Red Band" Motors their tough jobs.

They did! Performance alone brought bigger and bigger sales volume. Each year, more and more industries, like yours, learned to depend on Howell quality.

Today, modern construction of our motors does not make it practical to include the Red Bands, but their quality is the same or better than that of the motors that bore the famous Red Band.

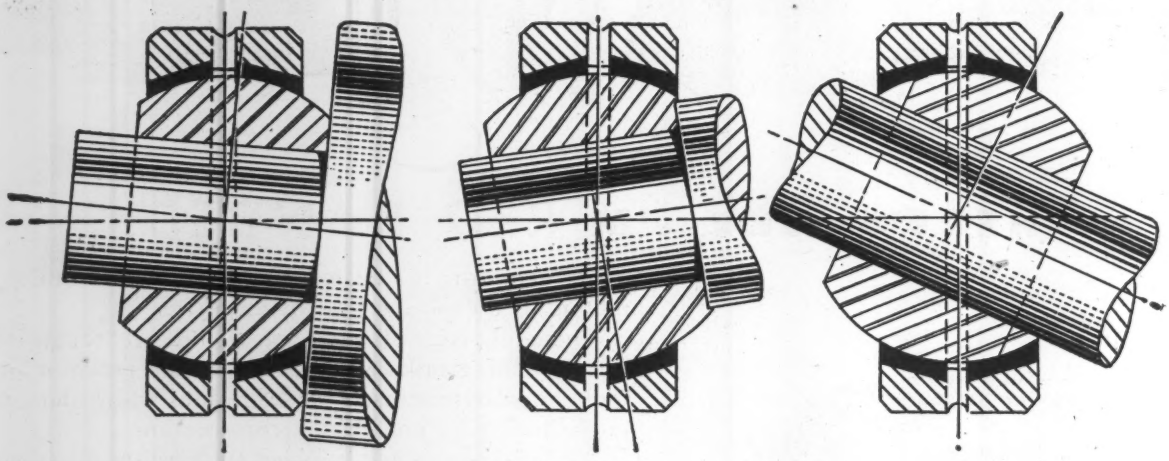
To remind you that we are continuing our high quality construction and that we are zealously guarding our reputation we have put the Red Bands on the friendly Howell Horse.

HOWELL ELECTRIC MOTORS COMPANY
HOWELL, MICHIGAN
Manufacturers of Quality Motors Since 1915

HEIM

UNIBAL SPHERICAL BEARINGS AND ROD ENDS

Correction of misalignment is provided for in all directions.



The day of competitive production is here, and you can meet that competition by planning your machines to include this new idea in spherical bearings and rod ends. Using one ball instead of a double row of balls in a race, cost is kept at the minimum, and heavier loads can be carried without breakage. A decided improvement in bearings whether applied to rod ends or used alone.

You have a place for Heim Unibal Bearings in your product. Our Engineering department is prepared to supply complete technical data concerning applications, load ratings, etc. Illustrated catalog of stock bearings is also available. Please write.

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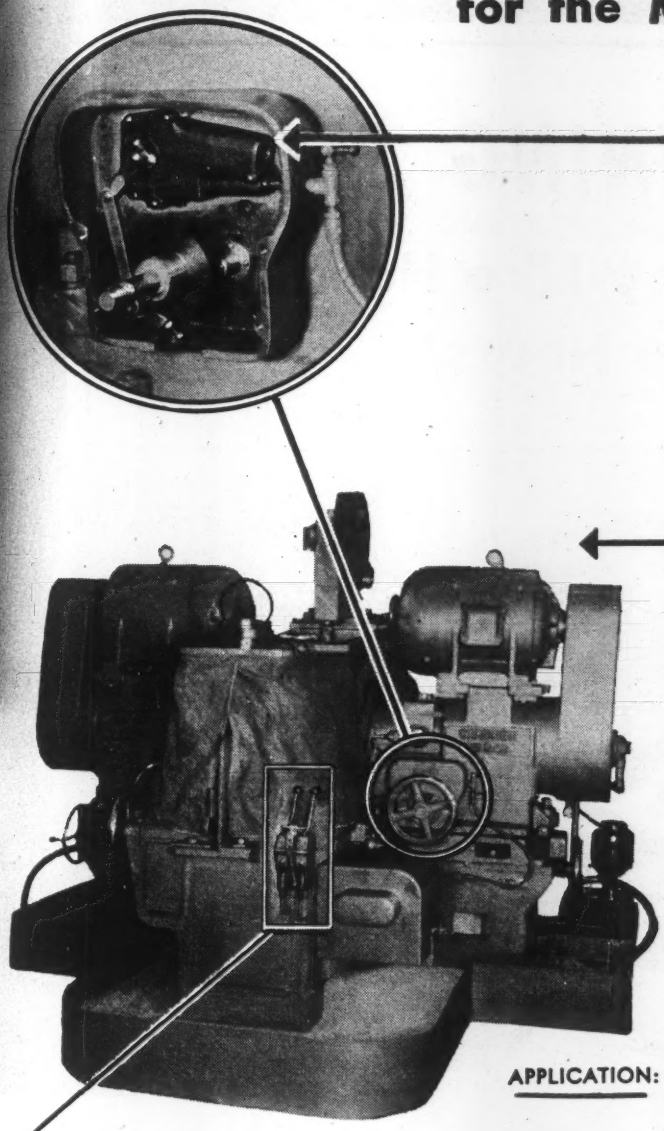
THE HEIM COMPANY

FAIRFIELD CONNECTICUT

SPERRY HYDRAULIC REMOTE CONTROLS for the MACHINE TOOL INDUSTRY



TRANSMITTERS ARE EASILY LOCATED IN MOST ADVANTAGEOUS POSITION

SPERRY'S HYDRAULIC CONTROLS minimize design problems by means of a single connecting tube that can be bent around corners and obstacles, or installed through walls, thus reducing design, installation, and maintenance costs.

The machine shown at the left is a No. 84B-30" GARDNER DOUBLE SPINDLE PRECISION GRINDER, manufactured by Gardner Machine Company, Beloit, Wisconsin. On top the canvas spray protection hood are several bearing races ground by this machine; turned out at high rates of production and to extremely close tolerances. 4" diameter races are ground at a rate of 40 per minute, holding ground surfaces to .0003" to .0005" of parallelism.

APPLICATION: Remote Control of operating feed on Gardner Double Spindle Precision Grinder.

PROBLEM: Original specifications called for Solenoid operated feeds. Initial installation presented the following difficulties:

a. Feed operated with too much shock on feeding mechanism.
b. Could not be relied upon to hold such necessary close infeeds as .0001".

SOLUTION: The Gardner Company changed to Sperry Hydraulic Controls with the following results:

a. Fast, smooth and shockless operation of infeed mechanism.
b. Hydraulic Control sensitivity eases the operation of infeed mechanisms.
c. Operator fatigue lessened due to one-position, centralized control.
d. Low maintenance and trouble-free operation of controls.

The above case-history is typical of the advantages secured by many Machine Designers and Product Engineers when they use Sperry's single-tube system to solve their remote-control problems.

EASY INSTALLATION
DEPENDABLE
ACCURATE

●

SEND FOR BULLETIN 78 FOR ADDITIONAL DETAILS

SPERRY

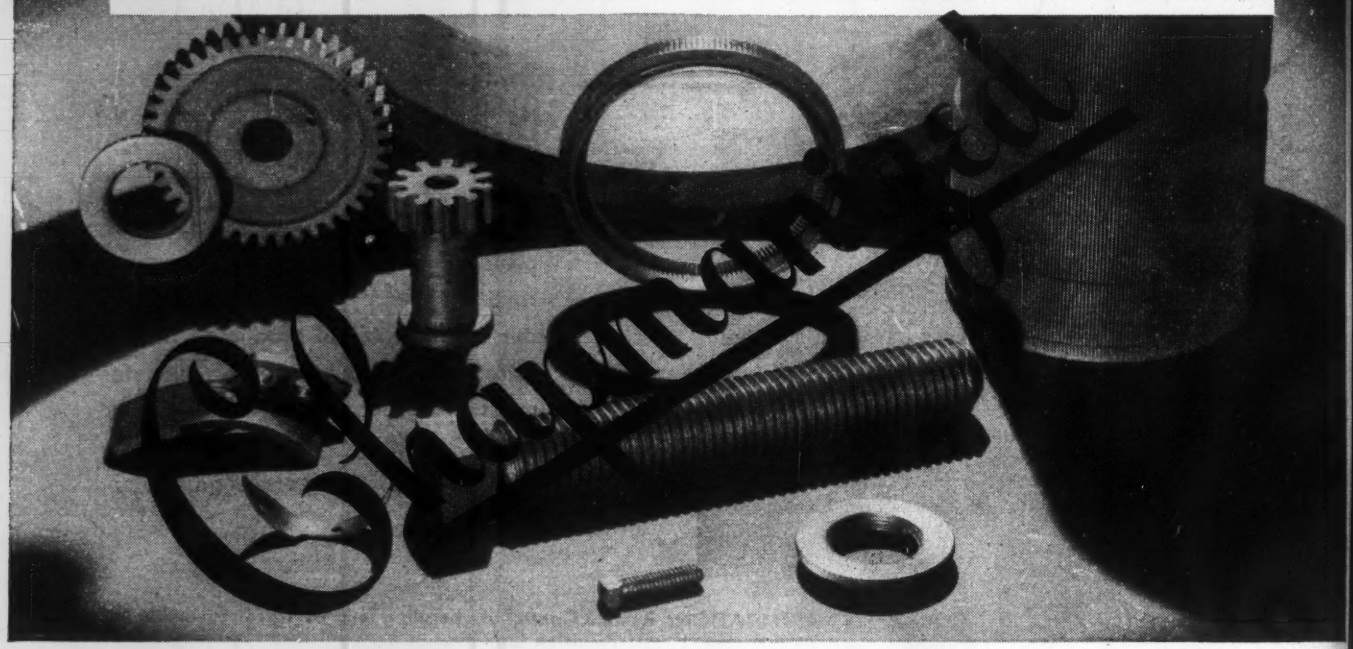
For Scientific Achievement

SPERRY PRODUCTS, INC.

HOBOKEN, N. J. CHICAGO, ILL.

FREE-MACHINING STEELS

Take on an Alloy-Like Hardness in 1 to 4 Hours!



Chapmanizing requires only 1 to 4 hours to produce a case from .002" to .035" deep—a case so tough and ductile it will not chip, check or warp. And Chapmanized surfaces are silver-clean—with distortion and growth reduced to a minimum. For this reason Chapmanized parts take less time to finish grind.

Save time and money by sending your free-machining steel parts to your nearest licensed heat treater. Or, if you prefer, you can Chapmanize in your own plant on a contract basis. We simply hook up Chapmanizing units to your present pot-type furnaces.

Let us send you complete information—Chapmanized samples, if you wish, with prices. Write to the

Metallurgical Sales Division of

The Chapman Valve Manufacturing Company

INDIAN ORCHARD, MASSACHUSETTS

Hansen air hose couplings keep down production costs by saving time, effort and air and also increase production considerably by saving the operator much time and many steps. The hundreds of thousands of Hansen couplings now in daily use on tools and equipment of all kinds is concrete evidence of their remarkable efficiency, performance and economy. Their adaptations are numerous and varied in many fields. Every day new applications are found for Hansen couplings, some on tools, others as part and parcel of various pieces of equipment, both large and small. Their simplicity in operation and absolute dependability make them a practical and efficient addition to any piece of equipment. To connect the Hansen air hose coupling you merely push plug into socket, coupling is connected and immediately the air is automatically turned on. To disconnect, slide sleeve back with thumb, coupling is disconnected and air is automatically turned off. They will handle pressures from 2 ounces to over 10,000 pounds without leaking.

There's a Hansen Coupling made for air, oil, grease, oxygen, gasoline and acetylene and they come in a wide range of sizes . . . Write for free industrial catalog.

THE HANSEN MFG. CO.

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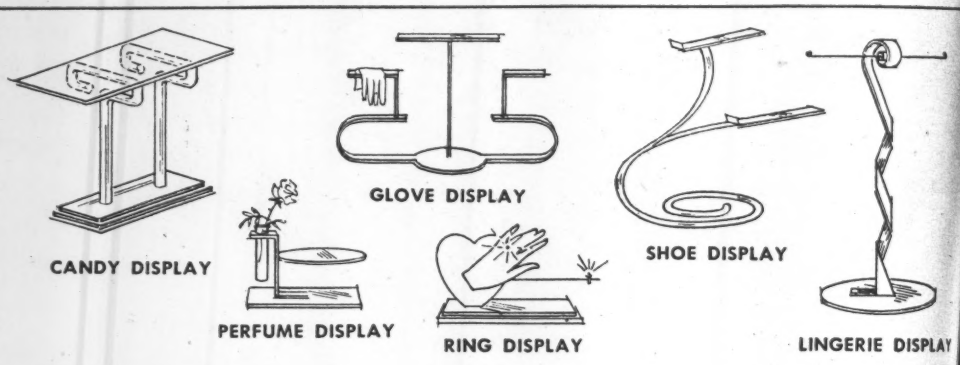
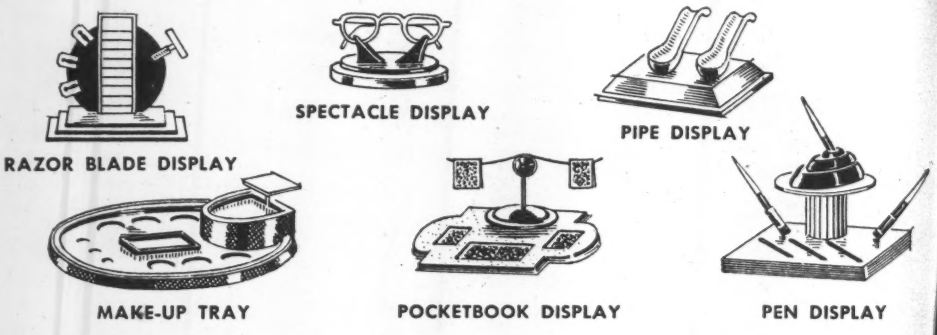
Plastics

IN THE DISPLAY FIELD

THERMOPLASTIC



THERMOSETTING



To reach a sound conclusion to your problem in plastics consult the skilled technicians—engineers and designers—of the General Electric Company. For advice on the successful application of plastics materials using all available processes of manufacture, write Section G-36, General Electric Company, One Plastics Avenue, Pittsfield, Mass., or call the General Electric Plastics Divisions' office nearest you.

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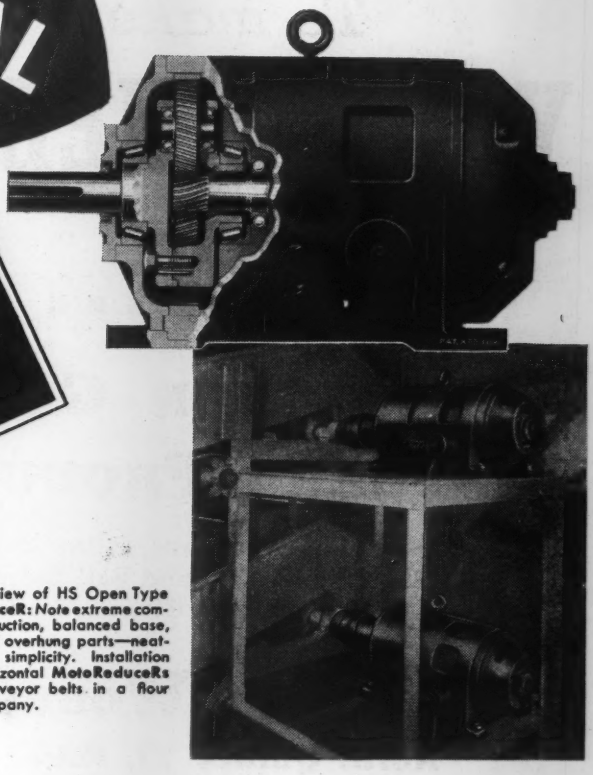
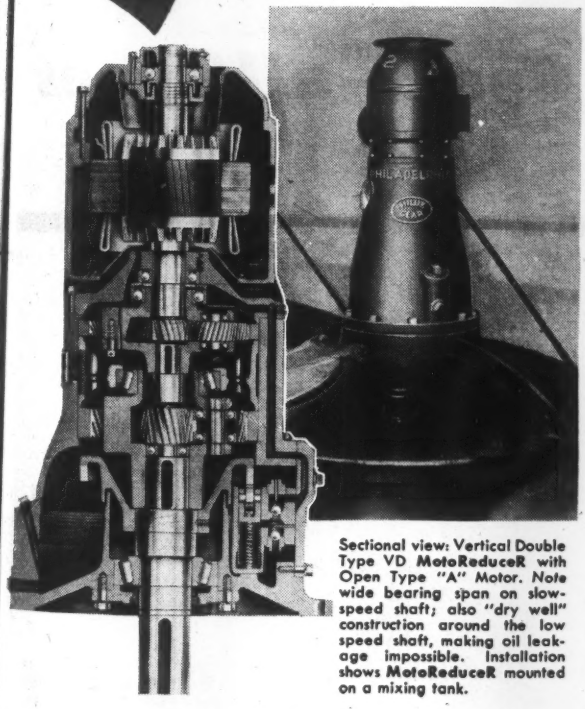


Sectional view of HS Open Type **MotoReduceR**: *Note* extreme compact construction, balanced base, and lack of overhung parts—neatness plus simplicity. Installation shows Horizontal **MotoReduceRs** driving conveyor belts in a flour milling company.

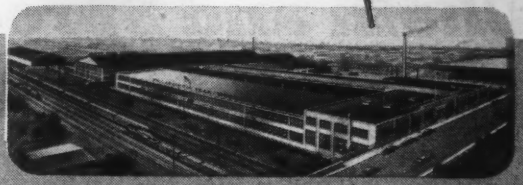


Sectional view: Vertical Double Type VD **MotoReduceR** with Open Type "A" Motor. *Note* wide bearing span on slow-speed shaft; also "dry well" construction around the low speed shaft, making oil leakage impossible. Installation shows **MotoReduceR** mounted on a mixing tank.

Here is the "very last word" in a self-contained, compact, smooth running, trouble-free Motorized Speed Reducer... the Philadelphia **MotoReduceR** is an "exclusive" product, and its design and construction is the result of 52 years' gear making and speed reducer experience.

Built in two types (Horizontal and Vertical), the **MotoReduceR** is the ideal combination of a high grade Motor and a Planetary Speed Reducer—a balanced, neat-appearing unit that operates with minimum vibrations and requires little or no attention. In addition every part is readily accessible; i. e. either the motor or the reduction gears may be removed without disturbing the others—and, they are easily bolted in place even in the most "out of way" places. Be convinced, send for new Catalog MR-45.

ARMY NAVY



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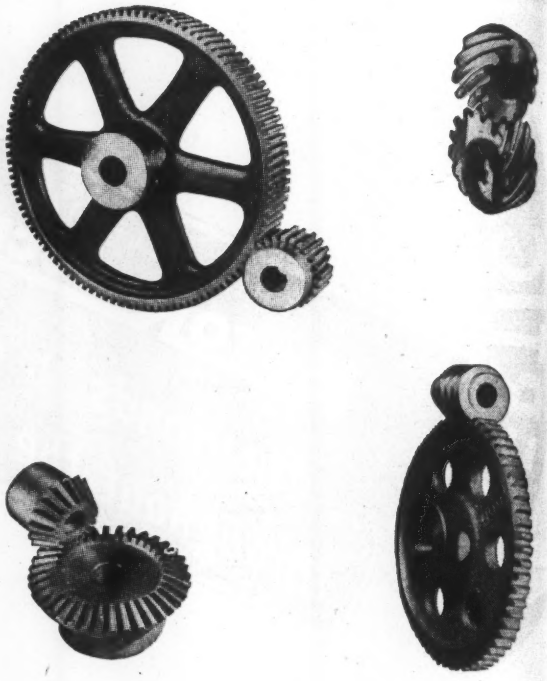
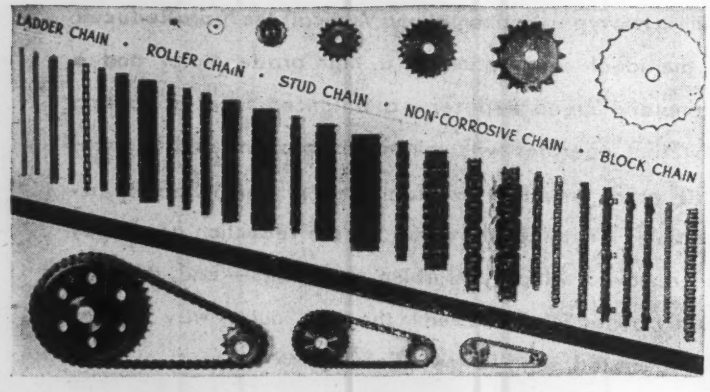


Gears – all Types



Chain and Sprockets both Ladder & Roller

Speed Reducers 24 Types

Every Machine Designer and Mechanical Engineer Needs This—Free Manual

Flaton Automatic Safety Clutches Offer These Advantages to Machine Builders

1. Prevent twisted shafts, broken gears, sprockets, chains, or belts where transmission system is subjected to sudden excessive shocks or blocking.
2. Positive overload protection for both driving and driven machines.
3. Efficiently functions at all speeds, even 1 r.p.m. or less.
4. Provides complete safety for workers if clothing gets caught in machine.
5. Completely automatic in operation, protecting machine at normal loads; stopping machine on overload, and resuming peak load when excess burden is removed.
6. Operates either clockwise, or counter-clockwise.
7. Unusually wide range of torque capacities.
8. Maintenance is negligible.
9. Will save their initial cost many times.

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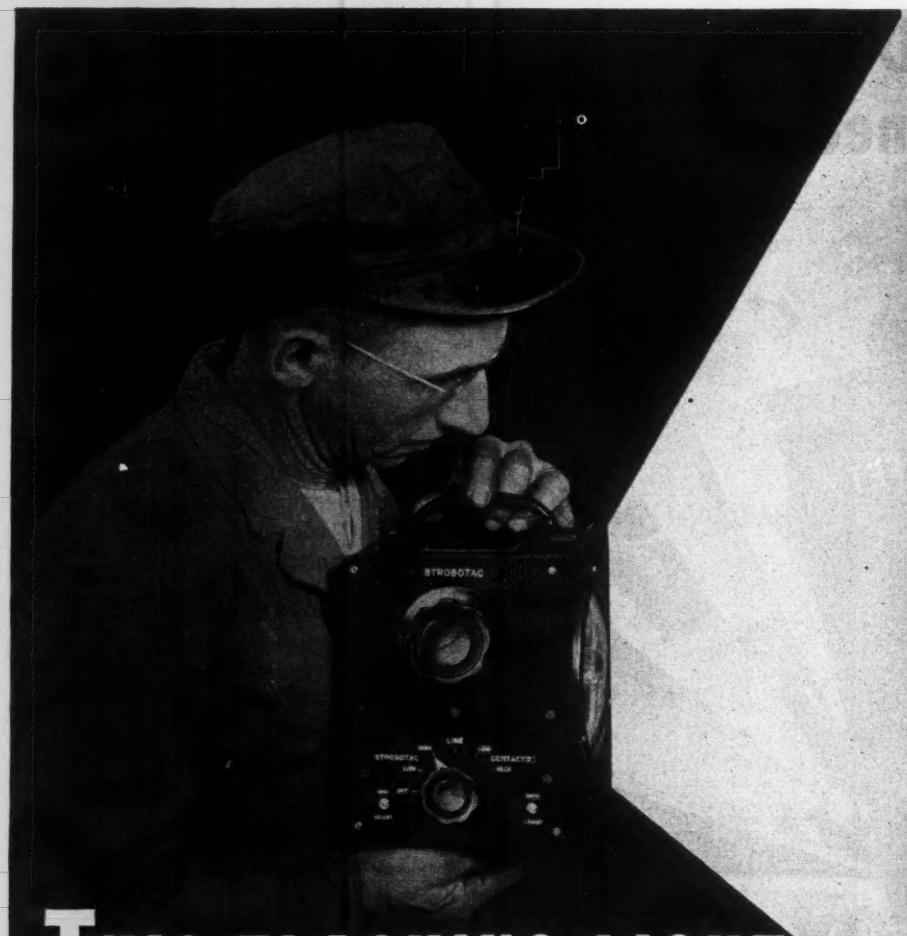
Name.....

Title.....



THIS FLASHING LIGHT CAN HELP YOU

● The General Radio STROBOTAC, the entire production of which has been devoted to military needs, is now available for civilian use.

In research, design, production, testing, sales and maintenance the STROBOTAC provides an invaluable tool where the *exact* operation of high-speed equipment (operating up to as fast as *100,000 rpm*) has to be seen in s-l-o-w motion, even as slow as a fraction of an rpm.

Thousands of STROBOTACS are in use throughout industry . . . thousands more will be used in the coming years in hundreds of different plants where any rotating or reciprocating machinery is being manufactured or operated.

STROBOTAC production is gradually returning to a peacetime basis . . . STROBOTAC deliveries are improving daily.

If you are interested in seeing the exact performance of any machine or part of any equipment while it is running at normal speed, you'll be interested in the STROBOTAC.

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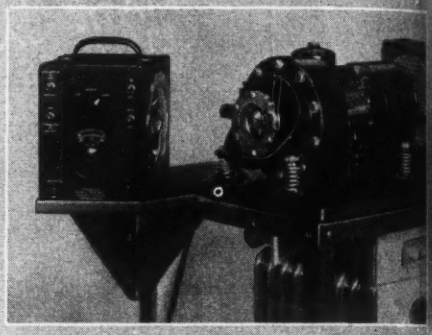

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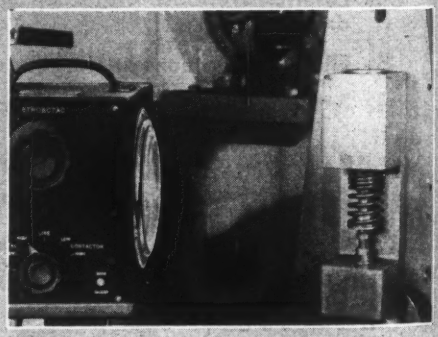
SCREW MACHINES



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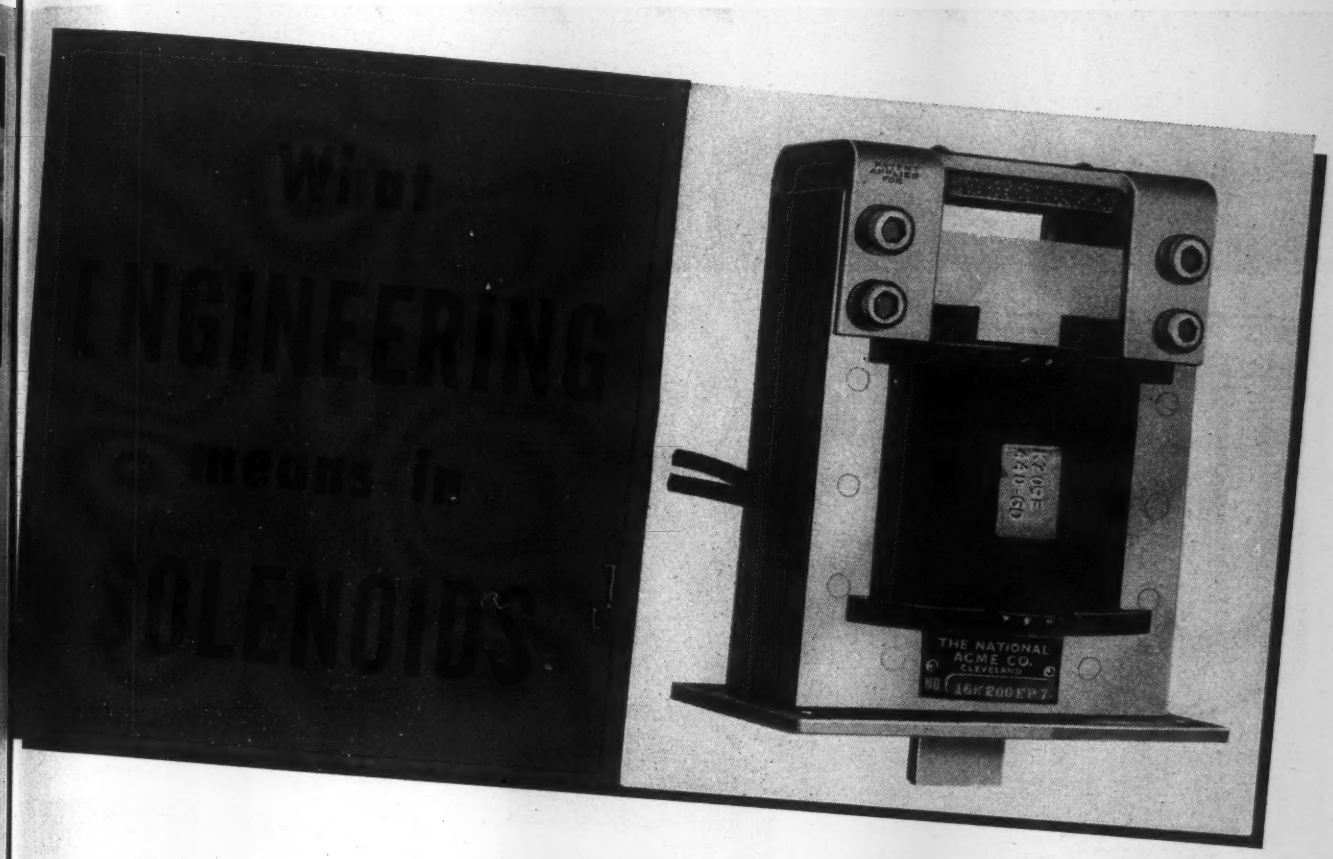

In this push - type Solenoid, we use a leather saddle, instead of the clips or pins commonly employed, to stop the return motion of the plunger.

The leather saddle distributes the impact of the returning plunger, absorbs shock, cuts down noise, and adds literally millions of contacts to Solenoid life.

A simple engineering idea—but it gives improved performance and longer wear wherever this type of Solenoid is used to operate hydraulic valves, brakes, clutches, switches, safety devices, etc.

Engineered Solenoids are now more widely used than ever—on tools and fixtures as well as the common uses above.

Namco Solenoids—with "Stellite"-welded plunger contacts, are compact, rugged and dependable.

Solenoids save many times their cost, by removing the need for complicated linkage, levers and other expensive moving parts that are subject to wear and get out of order. The net result of Solenoid application is generally better operation at *lower* cost.

Namco Solenoids are *engineered* to suit your job. Tell us what you want to accomplish—we'll recommend the Solenoid that will do it best. When there must be terminals on or near Solenoids, we'll also recommend the best suited standard terminal blocks, if you'll tell us style of housing or mounting.

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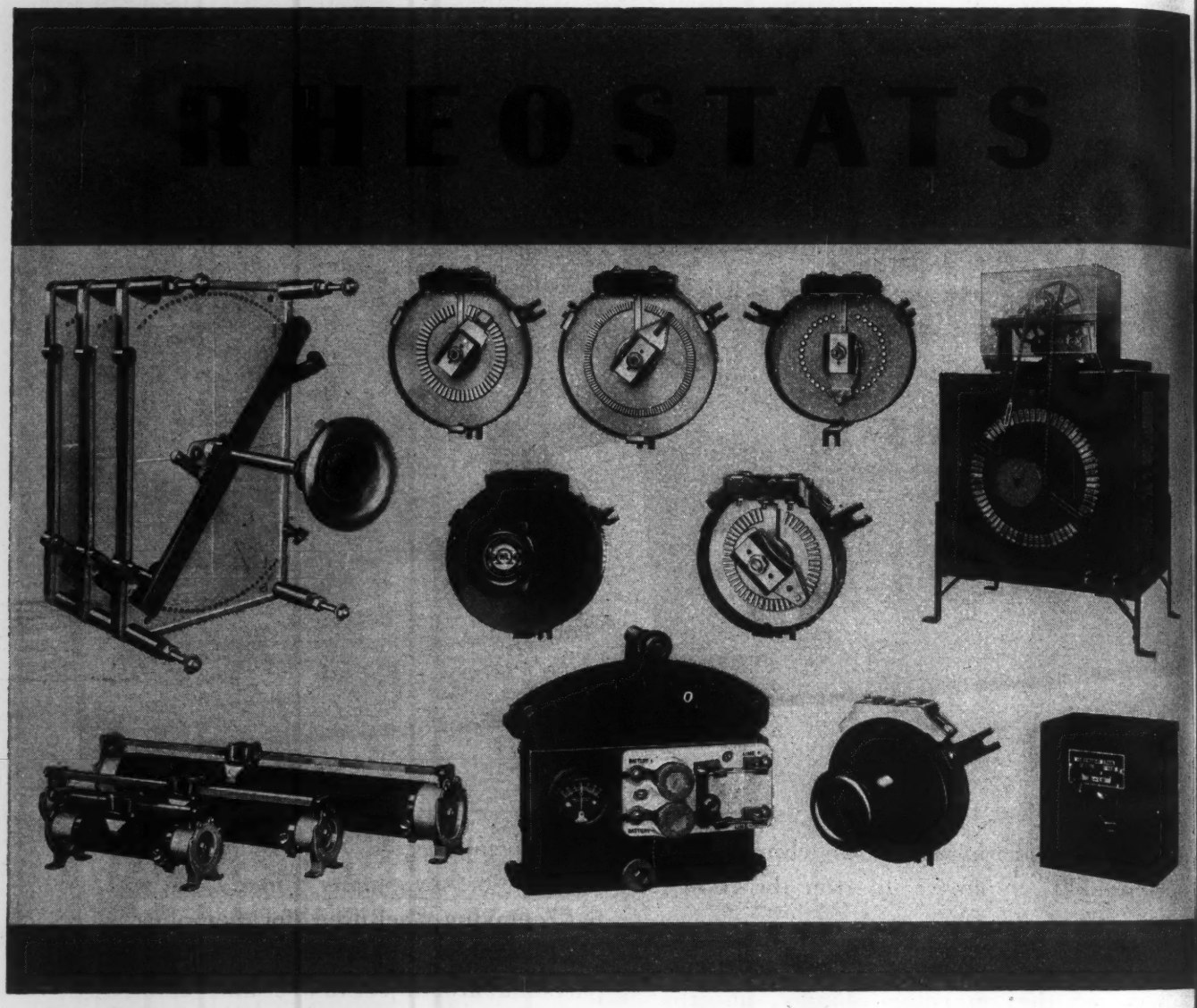

The Ward Leonard line of rheostats includes the widest range of sizes, tapers and current ratings from the tiny types for radio to huge multiple assemblies for the heaviest industrial use. Smooth operation, durable contacts and extreme dependability characterize all Ward Leonard Rheostats, Resistors and Relays. Write for bulletins of interest to you.

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food process equipment						
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laundry machinery						
lubricating systems						
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With more machines and processes on the planning boards, or in model stage, now than at any previous time in industrial history, alert designers are utilizing the implement of automatic control as a means for assuring a marketable product against stiff competition. Inherent advantages of Time Controls, such as simplicity of installation, ease of adjustment and accuracy, have been recognized and specified for thousands of applications which require precise control for duration and sequence of related electrically-actuated functions. In the specialized business of Time Control manufacturing for *industry* since the infancy of the art, ATC has been aware of its responsibility — supplying in all cases equipment which could stand the gaff and be relied on to do the intended job. Gadgets, as well as quality compromised to price, have never had a part in ATC design. This policy, which has gained widespread respect, is reflected throughout the entire standard line of ATC Timers. Systems, designed to meet special requirements, coordinate any number of consecutive or overlapping operations and are engineered by a staff with the widest experience available in this field. Investigate ATC Time Controls for your most simple or complex control job on your machines or processes. Confidences respected, of course. Write for data or see your Sweet's Product Design File.

*"Designed-in" Time Controls . . . the trend

Wherever one or more electrically operated devices must function in accurate relation to each other — for both duration and sequence — Timers can, in most cases, do the controlling job most accurately and efficiently. Complete panels, built to specified space limitations on machines or processes, may be comprised of interwired Timers, relays, push buttons, circuit breakers, switches, indicator lights, etc. — delivered as a unit package by ATC, ready for simple installation and hook-up to one clearly marked terminal block. ATC has supplied thousands of such systems to complete satisfaction of users.

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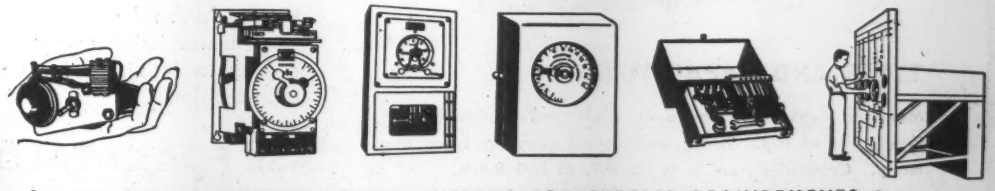

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Floating Disc CLUTCHES

Machine Tool Builders . . .

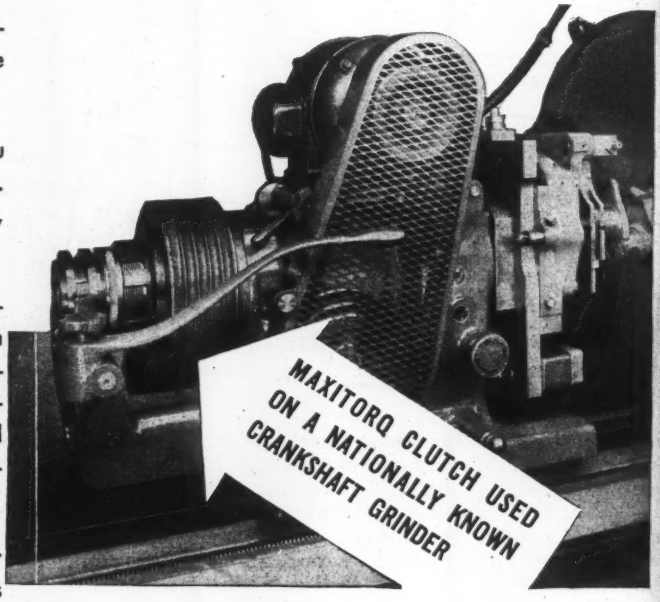
HERE'S REAL CLUTCH PERFORMANCE

For your new machines . . . for improved operation, check on the new advantages inherent in the Maxitorq Floating Disc Clutch.

Here's a clutch that "comes out in the open". You can see every part. Without using any tools . . . not even a screw driver . . . you can take it apart, assemble, adjust it.

Separator Springs (a Maxitorq patent), used between the discs, "float" them in neutral. You can see between them. That means no drag, no abrasion, no heating in neutral. Thus, disc life is prolonged. There's no question about instant and positive engagement and disengagement . . . controlled with the lightest pressure.

This is a worthwhile clutch specification for your new applications . . . especially since Maxitorqs cost no more, often less, than less satisfactory units.



TYPES AND CAPACITIES

Maxitorq clutches are made in single and double (above) types, wet or dry. Pulley and cut-off coupling types also made. Capacities from ¼ to 15 H.P. at 100 R.P.M.

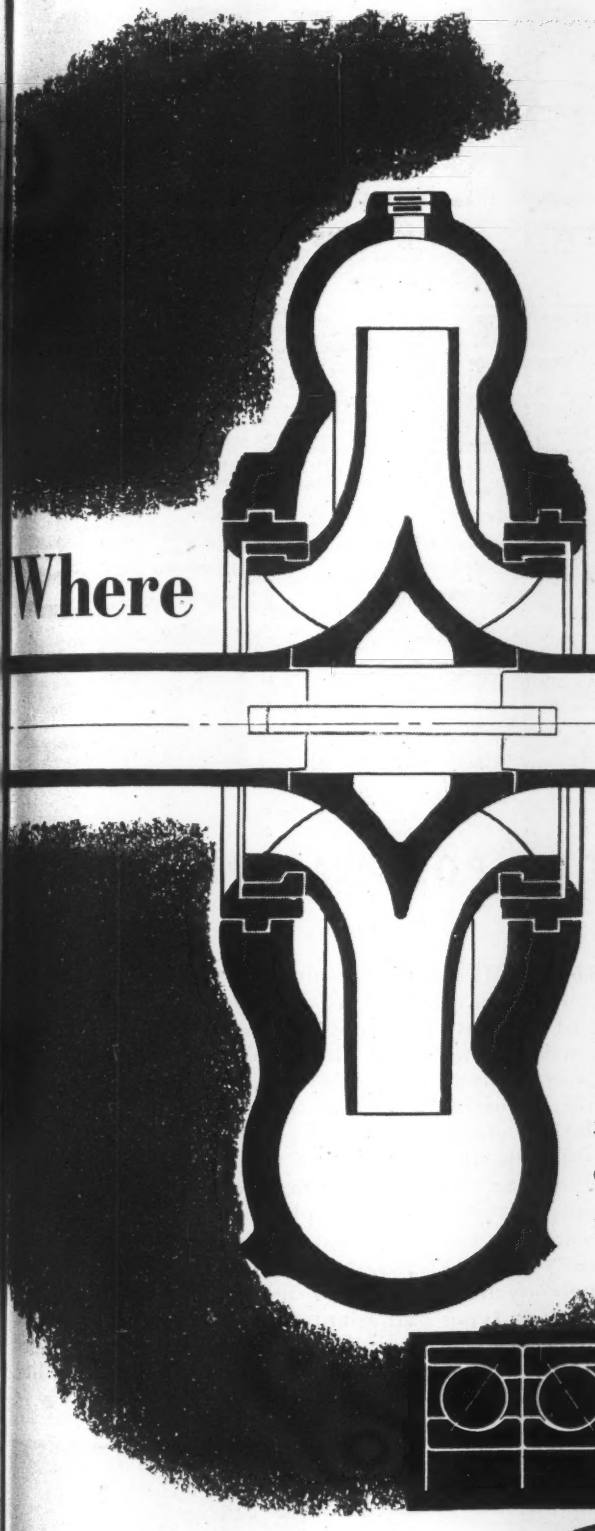
"MAXITORQ" approved for . .

The fast growing number of satisfied Maxitorq users is assuming the appearance of a "Who's Who" list of nationally known machinery manufacturers. A grinding machine, equipped with a Maxitorq, is shown above; others include packaging machinery, can labeling machines, commercial ice cream freezers, multi-spindle automatics, food, shoe and textile machines . . . and a host of others of equal importance.

They couldn't take a chance on any but top class power transmission equipment. Neither can you. So look to Maxitorq for dependable solution of your problems.

ASK FOR CATALOG NO. MD 12

THE CARLYLE JOHNSON MACHINE COMPANY · MANCHESTER, CONNECTICUT



A TIGHT-SPOT with a drive shaft . . . that's a centrifugal pump. It's necessary to fit the rotating element that does the pumping so closely inside the housing that clearances are extremely minute. That's how you get suction and it's also how you can get into trouble if there's end-play in the drive shaft. Only ball bearings can take that combination of heavy radial and thrust load and high speed and hold vital clearances.

Where End-Play is FOUL PLAY

It's Fafnir's job to take on tough jobs like this . . . and come up with a series of bearings such as the Duplex Units. Their greater ball complement and double angularity of load lines enable these bearings to take heavy loads with the ultimate in axial and radial rigidity. They maintain precise clearances between rotary element and casing, require minimum attention and last long beyond anticipated life expectancy.

It's the way Fafnir enters into working partnership with machine designers and machine users in offering practical solutions to any bearing problem that makes so many executives say, "Let's put it up to Fafnir." The Fafnir Bearing Company, New Britain, Connecticut.

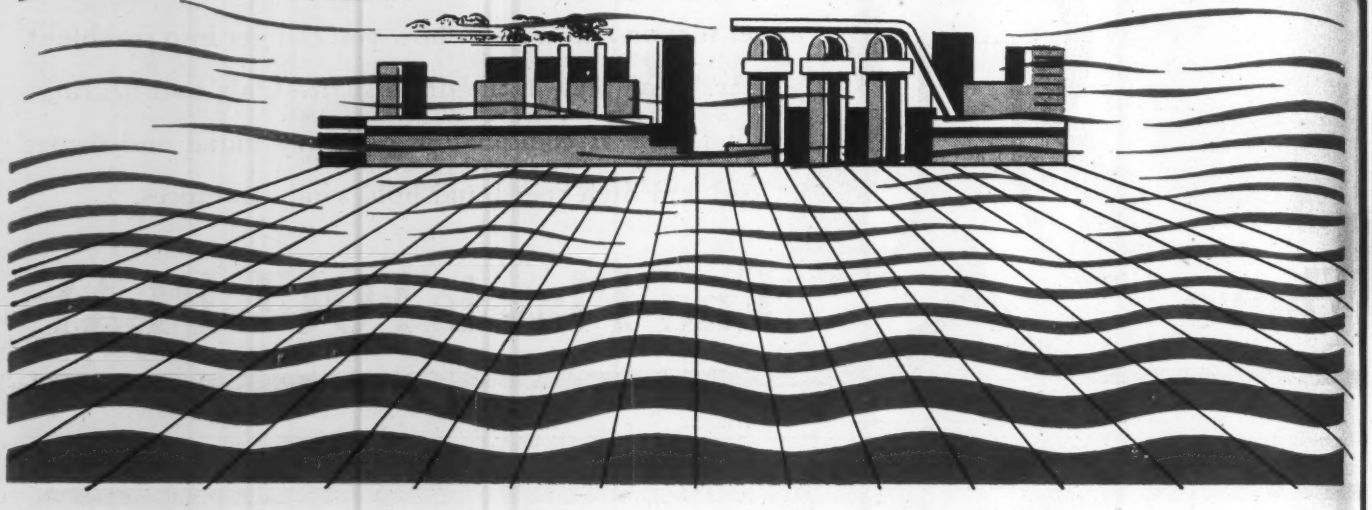
FAFNIR BALL BEARINGS

MOST COMPLETE LINE IN AMERICA

HAVE YOU INQUIRED HOW

THERMONICS*

CAN IMPROVE, SIMPLIFY



YOUR PRODUCT, YOUR PLANT, YOUR POST-WAR PLANNING

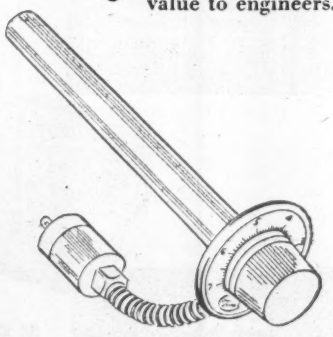
* **THERMONICS** is the science of temperature control developed by Fenwal, Incorporated, by the direct process of determining the needs of industry and science for unerringly accurate thermal control of wide applications. Many thousands of applications and tests have proven the efficacy of the *Fenwal Thermoswitch*, prime factor of this refined and exact science of Thermonics, which takes its place of due importance in the field of temperature control and thermal regulation.

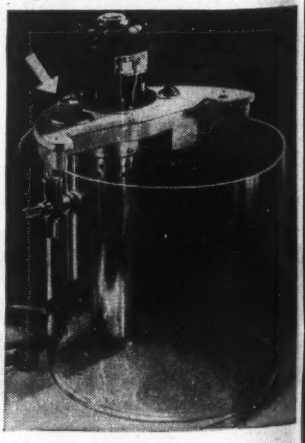
Thermonics as a science in itself earns and deserves the attention of:

- all processes and production requiring regulation of extreme or moderate temperatures;
- makers of equipment requiring light weight, compact, efficient thermal regulation;
- makers and users of machinery, equipment, vehicles, wherein a safety factor of controlling or indicating excessive or dangerous changes in temperature is essential.

THERMOSWITCH is the prime factor in Thermonics. So many are the functions of THERMOSWITCH, and so comprehensive is the field of Thermonics, that practically all processes of manufacture requiring accurate thermal regulation are served by THERMOSWITCH. Few, if any products whose efficiency depends on temperature control, exist today or are planned, that can omit the consideration of Thermonics in basic engineering *and the use* of THERMOSWITCH *for functional competency* and economy of operation. THERMOSWITCH in its many types and adaptations, offers a lightweight, compact vibration-proof, highly sensitive yet rugged regulatory and detectory unit of almost unlimited utility.

- Fenwal's data folder on Thermonics will prove of value to engineers. Your copy is ready for you.





Fenwal, Inc.

THERMOSWITCHES

FOR COMPLETE TEMPERATURE CONTROL

37 Pleasant Street, Ashland, Massachusetts

PRECISION BEARINGS

FOR EVERY LOAD, SPEED AND DUTY

108 DISTINCT SERIES

BALL, ROLLER AND THRUST

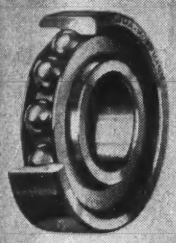
OVER 3000 SIZES

1/8" to 22 1/2" Bore—Metric and Inch Sizes

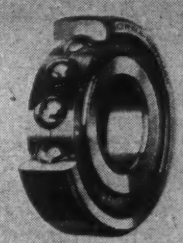
Write for the Catalog and Engineering Counsel

NORMA-HOFFMANN BEARINGS CORP'N.—STAMFORD, CONN., U. S. A.

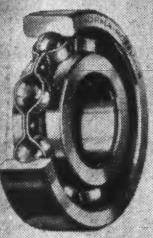
"NORMA-HOFFMANN"



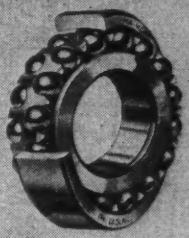
Separable (Magneto) Ball Bearing



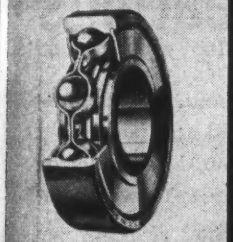
Litro ("CL") Composition Retainer Ball Bearing



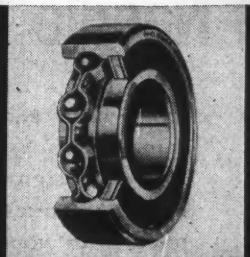
Single Row Ball Bearing



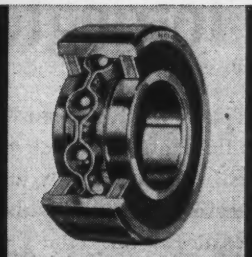
Double Row Self-Aligning Ball Bearing



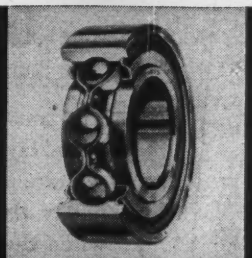
Shielded Type Single Row Ball Bearing



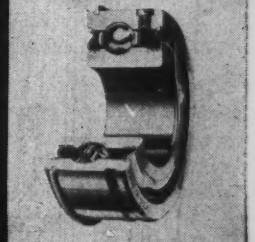
Single Felt Seal Ball Bearing



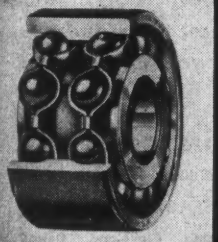
Double Felt Seal Ball Bearing



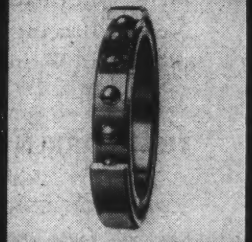
9000 Series (Feltless) Sealed Ball Bearing



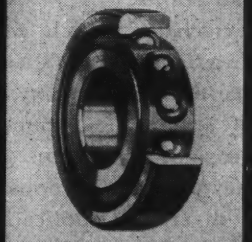
"Cartridge" Fully Sealed, Refillable Type Ball Bearing



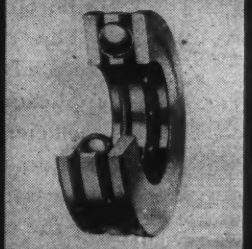
Double Row Ball Bearing



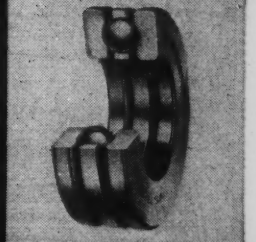
Extra Light Type Ball Bearing



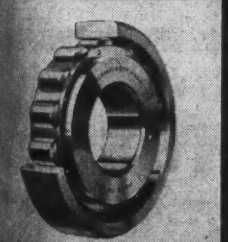
Angular Contact Ball Bearing



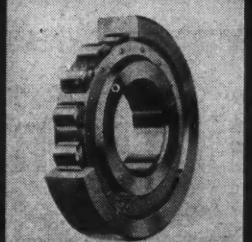
Extra Light Single Direction Ball Thrust Bearing



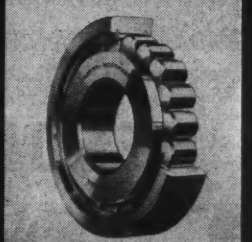
Single Direction Ball Thrust Bearing



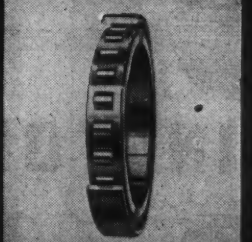
Standard Cylindrical Roller Bearing



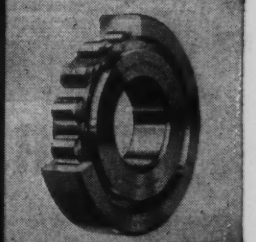
Type "E" Cylindrical Roller Bearing



Full Type (Retainerless) Cylindrical Roller Bearing

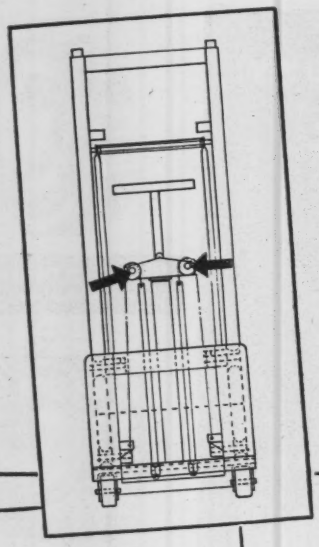


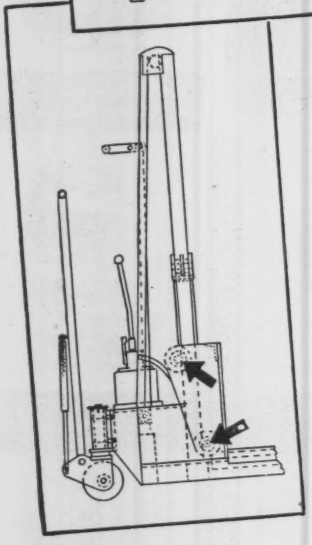
Extra Light Cylindrical Roller Bearing



Two-Lipped Cylindrical Roller Bearing

Arrows indicate where modern, anti-friction Needle Bearings are used in the Lyon-Raymond High-Lift Truck . . . in the sprockets which carry the roller chain connecting the platform with the hydraulic cylinder . . . and in the four concave rollers which guide the platform during elevating and lowering.





High-Lift Operates Smoothly on Torrington Needle Bearings

The moving parts of this Lyon-Raymond Hydraulic High-Lift Truck must operate as easily and efficiently while under the strain of heavy loads as when the pressure is off. That's why compact, anti-friction Torrington Needle Bearings are installed at the important load points.

The characteristics which make Needle Bearings ideal for this specific application are high load capacity, low coefficient of starting and running friction and ease of lubrication. And these same features are responsible for the many diversified applications of efficient Needle Bearings in a wide variety of equipment, such as machine tools, farm equipment, textile machines and household appliances.

If you design or build machines or equipment, our Catalog 32 was compiled with your needs in view. It contains a fund of interesting and helpful engineering data and complete information on Torrington Needle Bearing types, sizes and applications. Write for your copy today.

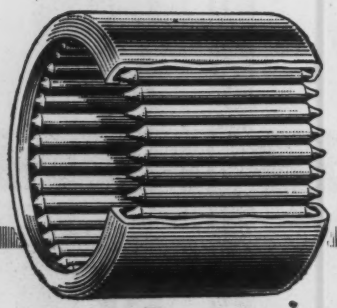
•

THE TORRINGTON COMPANY

Established 1866

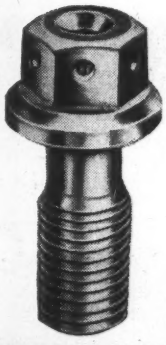
TORRINGTON, CONN. • SOUTH BEND 21, IND.

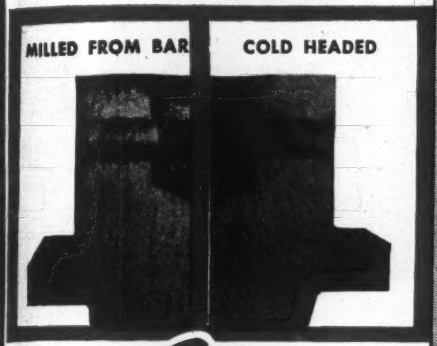
New York Boston Philadelphia Cleveland Detroit Seattle Chicago San Francisco Los Angeles Toronto London, England

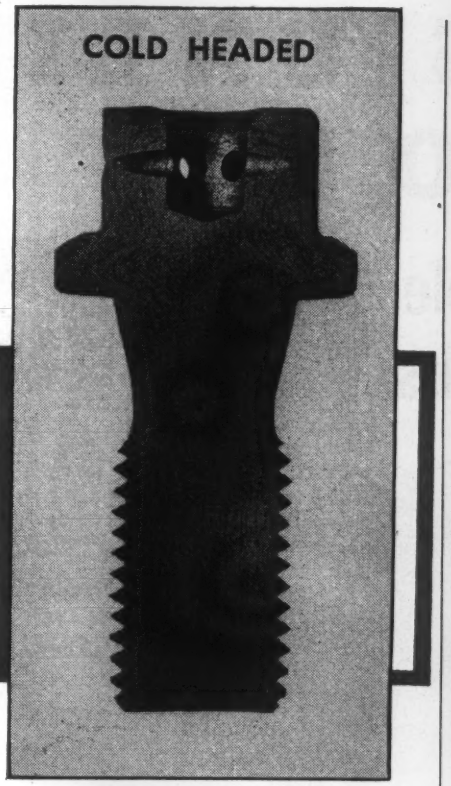


TORRINGTON NEEDLE BEARINGS

This cylinder hold-down screw is a Corbin Precision Part, affording a good example of intricate cold heading. Notice the flow lines in the microphoto.







a Choice of Primary Operations

Milled-from-bar or cold-upset? Corbin can do it either way . . . for Corbin facilities include a complete battery of modern cold headers capable of upsetting products from wire 1/16" in diameter to 1/2" diameter body size, with upset sections and extruded shanks as may be required. Tolerances as close as .002" on body diameters can be maintained. Special heading equipment, such as double end headers, rod headers, hand headers, and reheaders, is available for specialized production.

You're sure of the *best way* when you put it up to Corbin. P-6

Facilities are explained in this bulletin — which you will find in Sweet's File 4m10 for Product Designers. If you prefer that we send you a copy, please request it on your letterhead.

THE CORBIN SCREW CORPORATION

The American Hardware Corporation, Successor

NEW BRITAIN CONNECTICUT

CORBIN

See Sweet's Product Design Catalog, outline of Corbin Products and Facilities

Precision Parts

Because *wide-awake* inspectors at Corbin remove the culls and duds, and make sure that every Corbin Screw you receive is uniformly O K . . .

⊕ **CORBIN-PHILLIPS Recessed Heads**

⊖ **REGULAR SLOTTED Heads with Saw-cut Slots**

always correct in size and shape and centered accurately. These uniform features make for quick and easy driving. You'll save time when you use Corbin Screws. *And time is money!*

Look to CORBIN

for your requirements in Screws and Nuts . . . a full range in both CORBIN-PHILLIPS and Regular Slotted. Also AIRCRAFT Screws and Nuts to Governmental specifications.

See your Distributor

—also complete stocks at Chicago, New York and New Britain . . . and sales representatives who can "talk shop."

S-12

M3 MEN MATERIALS MACHINES **facilities**

that have made Corbin Headquarters for Precision Parts are producing highest quality Screws . Nuts . Chain.

Look to Corbin for

Standard Parts

RATIOS UNLIMITED

with OHIO T

differential variable speed transmissions

smooth, shockless acceleration from absolute zero to any desired speed

Every machine manufacturer and operator recognizes the wear and damage problems imposed by shock load in starting a machine. OHIO T Variable Speed Transmissions eliminate this problem entirely. They provide infinite ranges of smooth, shockless acceleration from absolute zero to any desired RPM.

If specified, OHIO T Variable Speed Transmissions may be designed to give constant torque throughout the entire speed range or to increase torque as speed is reduced. Another variation provides a range from any required speed in one direction through zero to the same speed in the reverse directions with equal torque maintained in both directions.

OHIO T Variable Speed Transmissions are simple, sturdy and compact in construction, efficient and long lived in operation. They are mechanical only involving, no friction drive, no hydraulic drive and no electrical equipment.

OHIO T Variable Speed Transmissions consist of mechanical differentials combined with a conventional variable speed reducer. The units shown above, Nos. OHIO T ½ and 3, are made by utilizing Link Belt PIV units Nos. ½ and 3 combined with OHIO differential transmissions of corresponding size.

Capacities range from 1 HP to approximately 20 HP

Many variations of these units, to suit specific applications, may be supplied. Our engineers will be glad to discuss your problem with you and make specific recommendations.

REPRESENTATIVES

*NEW YORK 13, N. Y.
Patron Transmission Co.
129 Grand Street

NEW ENGLAND
George G. Pragst
P. O. Box 995, Pawtucket, R. I.

*LOS ANGELES, CALIF.
J. W. Minder Chain & Gear Co.
927 Santa Fe Avenue

GRAND RAPIDS 8, MICH.
Slaughter Manufacturing Co.
3753 Division Ave. S.

*PITTSBURGH, PA.
Standard Machinists Supply Co.
South 2nd and McKean Street

DETROIT 2, MICH.
George P. Coulter
322 Curtiss Building

**Stocks carried.*

*MINNEAPOLIS, MINN.
Industrial Supply Co.
1100 Third Ave., South

BUFFALO 16, N. Y.
F. E. Allen
1315½ Hertel Ave., Room 9

*KANSAS CITY, MO.
Kansas City Rubber & Belting Co.
712 Delaware Street

*SAN FRANCISCO, CALIF.
Adam-Hill Co.
244-246 Ninth St.

LOUISVILLE, KY.
Alfred Halliday, 330 Starks Bldg.

INDIANAPOLIS 4, IND.
A. R. Young
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ST. LOUIS, MO.
St. Louis Tool Co.
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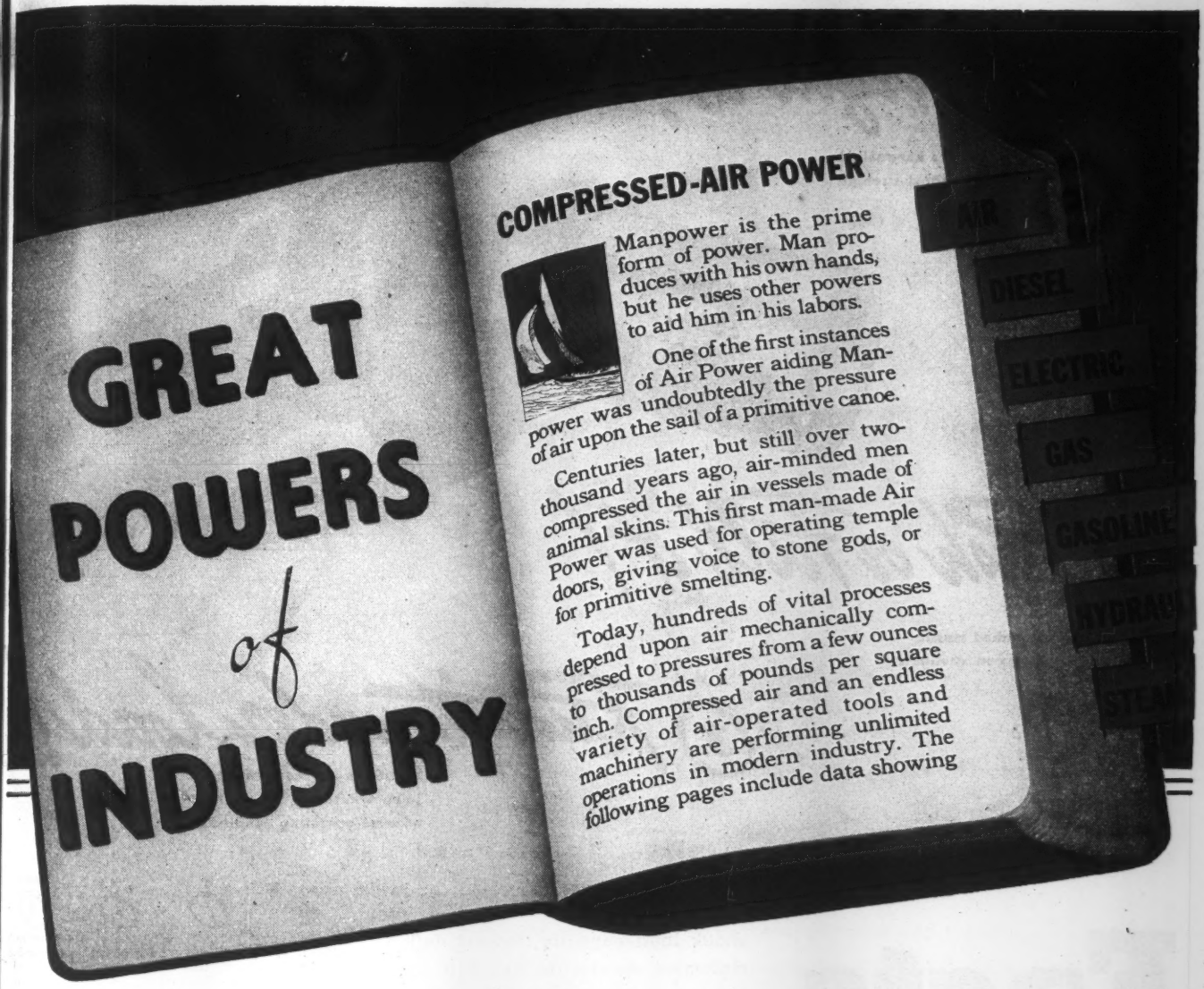
THE OHIO GEAR COMPANY
1338 EAST 179th STREET • CLEVELAND 10, OHIO

OHIO GEARS



This book is not for sale . . . as far as we know, it does not exist.

If it did, such a book would point out the types of work that can be accomplished by *several* forms of motive power used by industry . . . the problems that can be solved *better by one* than by any other . . . the things that can be done by *only one* of them . . . and the still other jobs that require *combinations* of several powers.

In the absence of such a book, we must all depend upon experienced engineers and manufacturers to advise us of the very latest practices in their particular fields.

So if you are not thoroughly familiar with *Compressed-Air Power* . . . what it is doing for others, and what it can do for you . . . get in touch with an Ingersoll-Rand Engineer. He knows Air Power and its applications.

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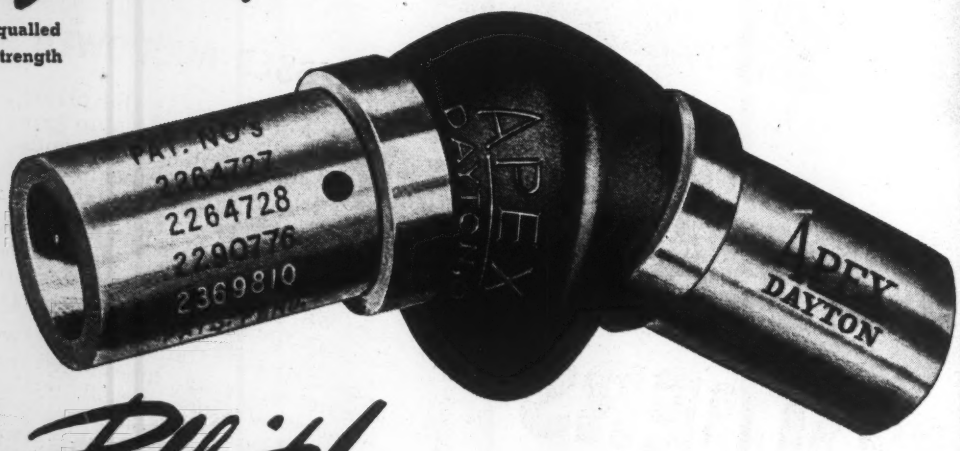
1-632

COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • OIL AND GAS ENGINES

* 1. Torque it!

It has unequalled torsional strength



** 2. Push or Pull it!

It has unmatched tensile and compression strengths

*** 3. Run it under load!

It outlasts any conventional joint, withstands the most adverse operating conditions

Facts

demonstrate beyond question that Apex Heavy Duty Universal Joints are stronger, lighter, will outperform and outlast any joint you can buy.

The Reasons: Apex exclusive design balances the strength of the yokes, block, and pins to provide greater static and operating torque, highest shock load capacity, lowest deflection and maximum freedom from binding under overload. Apex exclusive cover (optional) seals lubricant in, seals foreign matter out, dampens vibration, minimizing fatigue and wear. More: it permits running Apex joints in corrosive or dust-laden atmosphere, in water, caustics, acids, etc. Apex joints won't throw oil, will not freeze at minus 75°F. nor fail at plus 250°F. Unprecedented performance in any adjustable multiple-spindle drill. Sizes: ⅜ to 4 inches. Style of barrels: you name it. Write for Apex Joint "Data Rule."

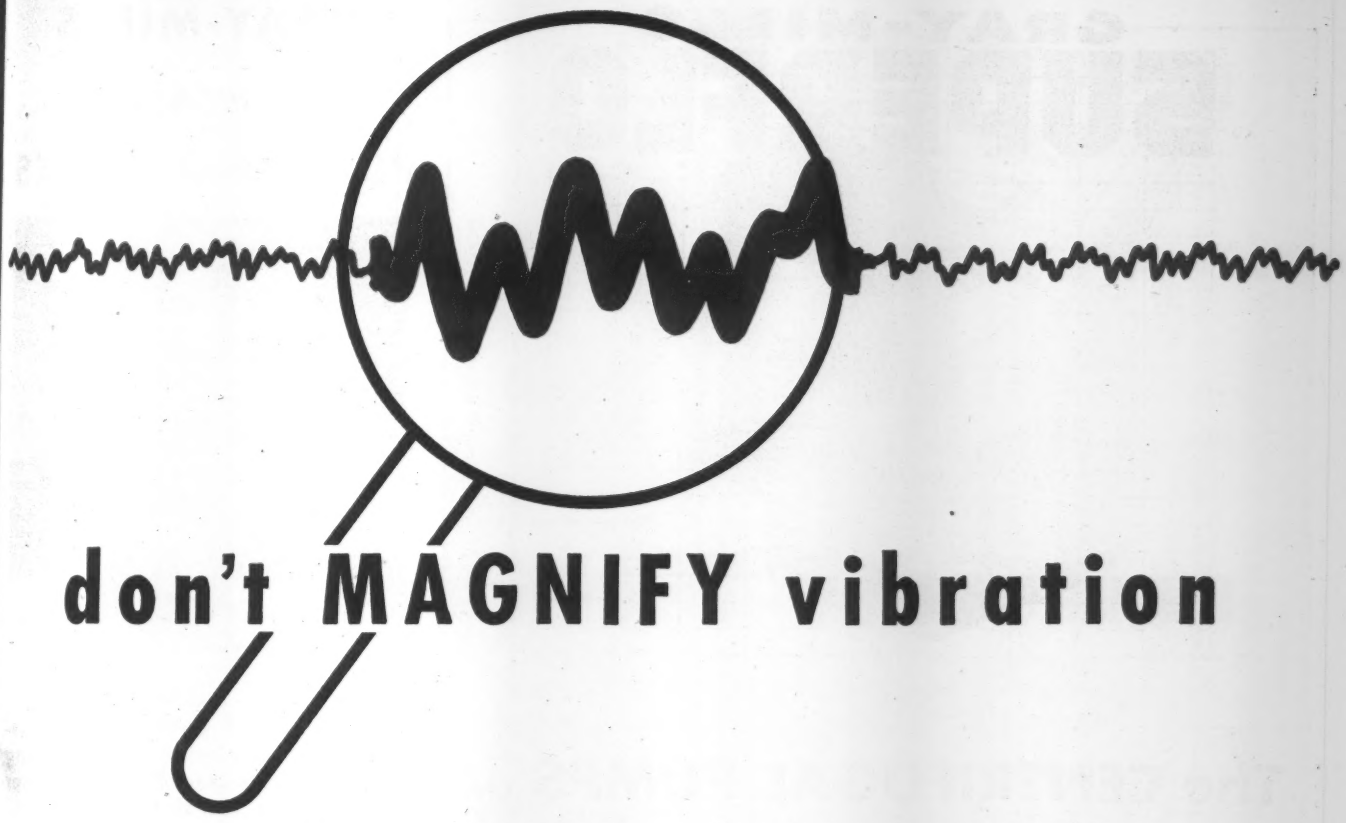
Nominal size (inches)	* 1. Static torque (inch-lbs.)	** 2. Axial ten. & compres. (lbs.)	*** 3. Recommended operating torque (inch-lbs.)
3/8	220	440	36
1/2	480	800	81
5/8	860	1,200	145
3/4	1,760	1,600	300
7/8	2,800	2,000	475
1	4,000	2,400	675
1 1/4	8,000	3,600	1,350
1 1/2	11,600	4,800	1,950
1 3/4	14,000	6,000	2,300
2	26,000	10,000	4,300
3	65,000	20,000	10,350
4	140,000	50,000	21,000

APEX

Industrial Universal Joints

THE APEX MACHINE & TOOL COMPANY • DAYTON 2, OHIO

Exclusive Licensee Under F. & S. Joint Patents



don't MAGNIFY vibration

Scientific isolation of vibration demands the control of all modes of vibration. Unscientific application of vibration-isolators usually neglects some modes and can actually magnify the vibration in these modes.

This is why the utmost care must be taken to pick the *right* vibration-mount—if the ultimate in vibration control is desired.

It also explains why *Barrymounts* are *engineered* to the application and the job. Of course, Barry does manufacture some standard mounts. These, however, are sold only on approved applications.

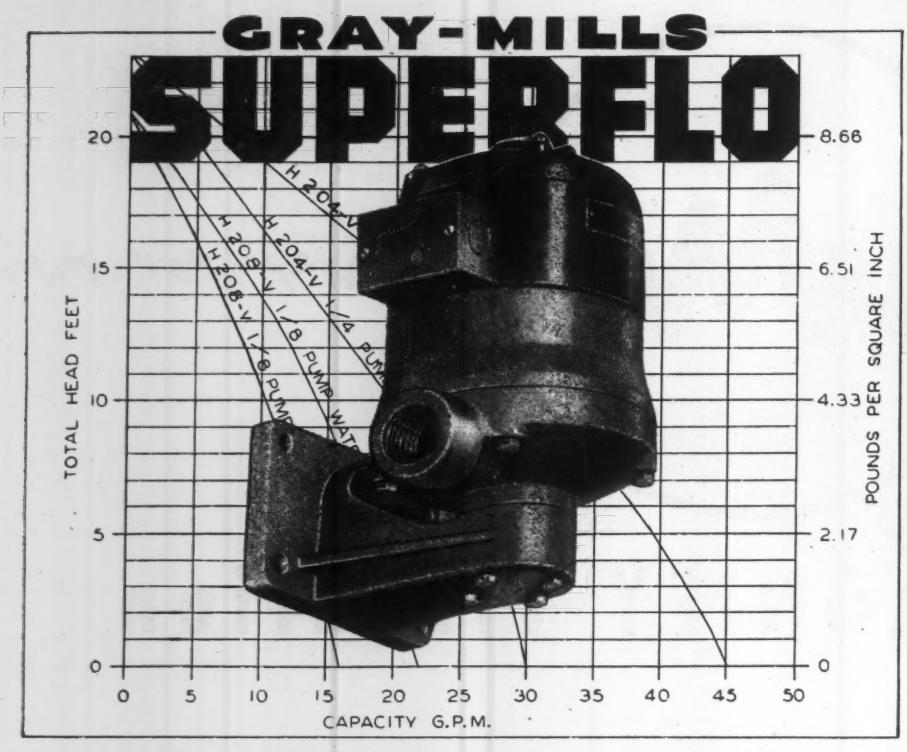
Certified Barry Vibration Engineers stand ready to serve you, without obligation, in all your design, engineering and production problems involving shock and vibration control. They have advanced knowledge, ability and skill combined with superb test and manufacturing facilities that assure the finest service available in this important new field. Take advantage of them today.

HERE ARE A FEW OF THE MACHINES IN WHICH *BARRYMOUNTS* CURE VIBRATION AND KILL NOISE:

Air conditioning eqpt
Radios & Radar
Refrigerators
Motors
Measuring instruments
Test equipment
R. R. equipment
Industrial Electronic eqpt
Washing Machines
Compressors
Blowers
Industrial Machinery, etc

WAR-TESTED FOR PEACE

GRAY-MILLS SUPERFLO



The CENTRIFUGAL PUMPS of *Superformance!*

- **More volume per horse power**
- **Service-free performance**
- **Compact... Streamlined design**

Here indeed are the ideal centrifugal pumps for modern machines. Streamlined, compact, easily installed on almost every type machine, they offer decided advantages to engineers planning new equipment.

The advanced design and built-in efficiency of Superflo Pumps gives them increased capacity to the point where, a 1/8 H.P. model is equal in volume delivered to many 1/4 H.P. pumps.

Superflo's integral-streamline design gives compactness, strength and ease of installation. Dependable—service-free in performance, they are ideal for pumping coolants, cutting oils and lubricants, and are easily adapted to any machine. The flow can be regulated from a drip to a full stream without overloading the motor. Capacities from 9 to 44 gallons per minute. Models available for fluids with high abrasive content. There's a Superflo Pump for "superformance" on almost every application . . . for replacement or as original equipment. Write and tell us your needs.

Models for Most Every Need

For horizontal-external mounting.

For submerging in coolant reservoir.

For submerging in tank and mounting to cover.

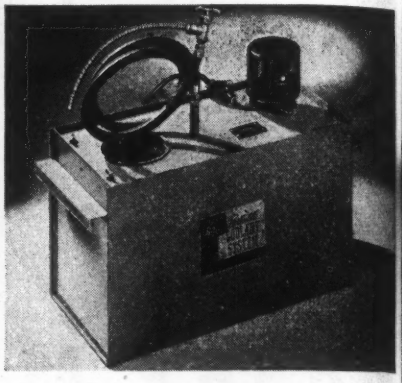
For submerging in tank, or mounting integrally with cover.

GRAY-MILLS CO.
1931 Ridge Avenue Evanston, Illinois

GRAY-MILLS **SUPERFLO CENTRIFUGAL PUMPS**

PORTABLE COOLANT SYSTEMS • PORTABLE PUMPING UNITS
INDUSTRIAL FLUID REFRIGERATION • PARTS CLEANING SYSTEMS

GRAY-MILLS *Portable* PUMPING UNITS



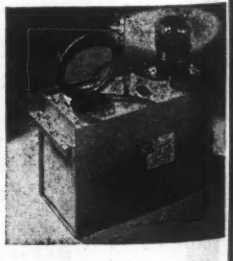
Gray-Mills Centrifugal Model. Available in two models—540 gallons per hour and 2650 gallons per hour at 4 foot heads.

FOR PUMPING
Coolants and Cutting Oils—Lubricants—Solvents—Quenching Fluids—Inks and Paints—Other Fluids and Solutions.

In hundreds of industrial applications Gray-Mills Pumping Units are supplying fluids, such as those listed above, for a variety of uses. These compact, self-contained systems apply a fluid at the point of use, either in constant flow or intermittently. They may be used for recirculating fluids, as in a coolant system—or to pump liquid from one point to another.

Think over your fluid handling problems—perhaps you'll find a Gray-Mills unit is a simple, low-cost answer—and if you have a special problem, there is a Gray-Mills engineer ready to help you work it out. Write for catalog and full details.

Model G Series. For capacities from 60 to 130 gallons per hour, pressures from 10 to 20 lbs. p.s.i. Tank capacities 3½ and 5 gallons.



Model A Series. For capacities from 60 to 180 gallons per hour, pressures from 10 to 50 lbs. p.s.i. Tank capacities 10 and 12½ gallons.

GRAY-MILLS CO.
1931 Ridge Ave., Evanston, Ill.

"I'm like the Saxaphone Player who blew Sweet—but it came out sour," MOANED THE DESIGNER

NILMERG: You are unduly pessimistic, Sir.

DESIGNER: Think so? Then take a look at this. My brain conceives a gloriously modern airport—but my fingers produce a Jules Verne nightmare.

NILMERG: Behold—a transformation, friend. Take this wonderful WINNER Thin Lead Colored Pencil in your fingers—see, they already behave better. Now a deft touch here, a bit of blending there—now pour on the color in this area—isn't that a magnificent effect?

DESIGNER: Jumping Jehosophat, a miracle. Does The WINNER Thin Lead come in other colors?

NILMERG: Indeed it does. In addition to Red, there are Blue, Green, White, Brown, Carmine, Blueprint Yellow and Blueprint Orange. Moreover, The WINNER Thin Lead is first choice of Artists, Architects, Engineers, Designers and Draftsmen because it is practically insoluble in the perspiration of your hands.

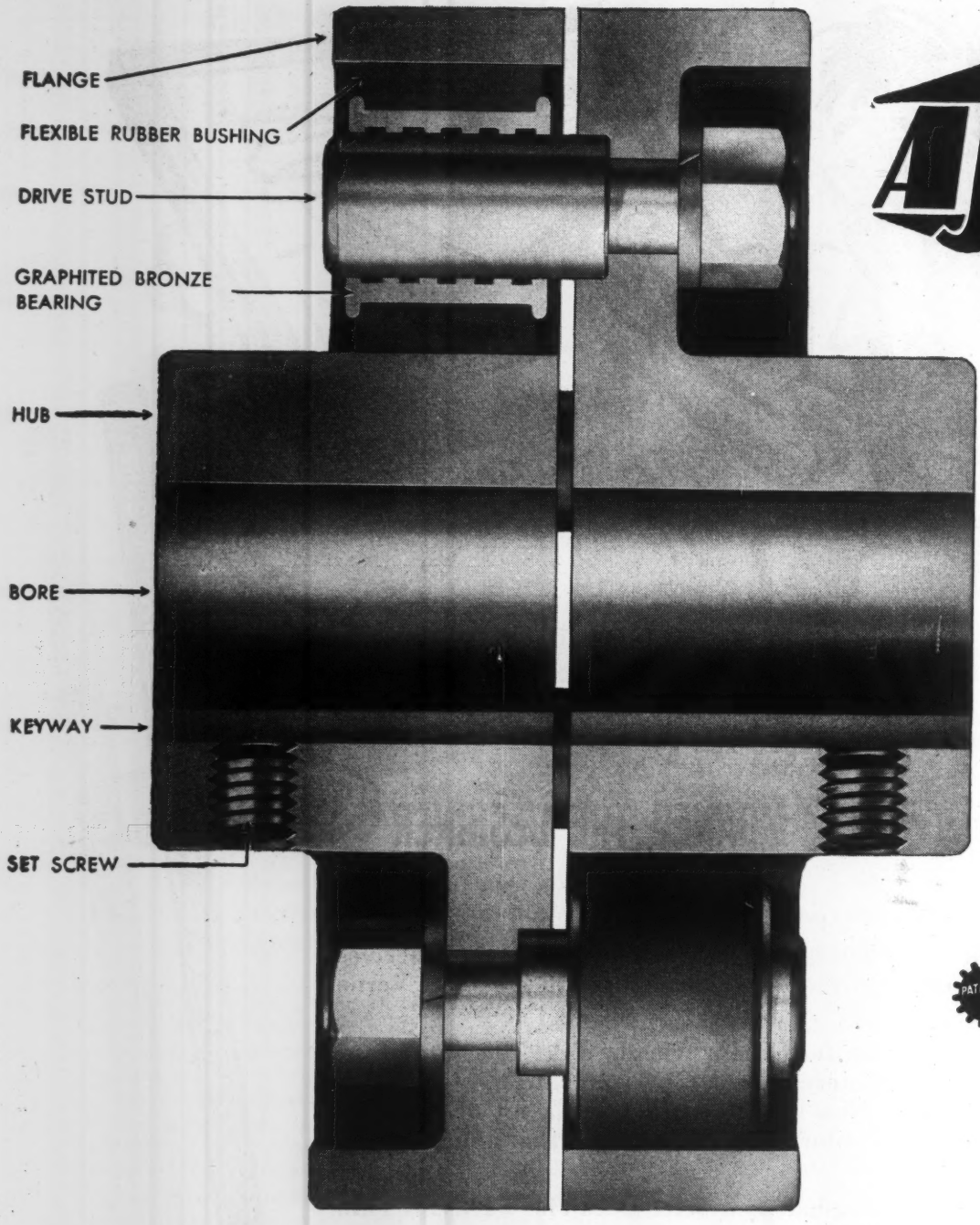
DESIGNER: You mean no smudges and fingermarks on my drawings?

NILMERG: That is precisely what I mean.

DESIGNER: You know, if you weren't a gremlin I'd kiss you. In fact, I will anyway . . . .

A.W. FABER • Inc., NEWARK, N. J.

The WINNER thin lead COLORED PENCILS



AJAX

Incorporated 1920

PATENTS MAKE JOBS

THE INSIDE STORY OF AJAX FLEXIBLE COUPLINGS

Ajax Flexible Couplings protect direct connected machines from unavoidable misalignment. They require no lubrication. They are quiet running — no backlash, no noise. They provide free end-float which permits electric machinery to find its magnetic center. They operate satisfactorily in abrasive-laden air.

They are built in a wide range of sizes and capacities with standard couplings *made of forged steel or cast semi-steel.*

For special requirements flanges can be machined from aluminum, bronze or other metals, and can be plated with chrome, silver or cadmium for protection against adverse atmospheric conditions. Thousands of cadmium-plated Ajax Couplings are running on U. S. Navy equipment throughout the world.

Ajax Couplings can easily be made integral with brake drums, pulleys, fly wheels, etc.

Write for new catalog giving complete data.

AJAX FLEXIBLE COUPLING CO. INC.

WESTFIELD, N. Y.

THE IMPROVEMENT OF METALS BY FORGING

The development of metal quality by forging is accomplished when a design utilizes fully the fiber-like flow line structure of the metal, and by the employment of a correct forging technique for the maximum IMPROVEMENT OF METALS BY FORGING. This hook forging illustrates how maximum metal quality can be developed to the exact degree required for a given service condition. In forgings, you can obtain high tensile and impact strength, toughness and fatigue resistance in both simple and highly stressed parts. A Steel Improvement Forging Engineer can help you obtain maximum metal quality through sharing with you 31 years of forging production experience. Fortify your product with the sound metal quality obtainable in forgings.

Reference Data Booklet presents many new ideas on forgings and their applications in many different types of equipment. Copies available to engineers, metallurgists and executives.

THE STEEL IMPROVEMENT & FORGE CO.

954 East 64th Street CLEVELAND, OHIO

McGILL SOLIDEND MULTIROL BEARING

INNER RACE ASSEMBLY

This new McGill Inner Race and Roller Assembly is similar in design to our well known Solidend Multirol Bearing. The inner race and roller assembly is a self-contained unit . . . the rollers cannot drop out. Small radial space is required, and great load-carrying capacity is obtained. Typical application is the constant mesh gears in transmissions. Ask for Bulletin No. I.R-45.

McGILL MANUFACTURING CO., INC., VALPARAISO, INDIANA

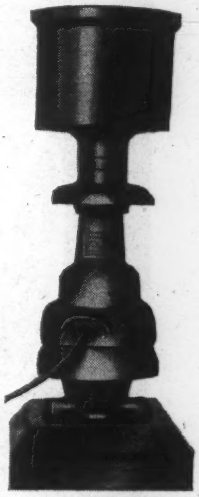
MANUFACTURERS OF BALL AND ROLLER BEARINGS

MOTORS THAT HAVE *Raised the Eyebrows* OF DESIGNERS

Motors that would have astonished many design engineers just a few years ago are now in regular production in G-E motor plants. Engineered to meet highly special needs, these motors (three examples shown here) have outdistanced conventional motor designs in shape, size, speed, and output.

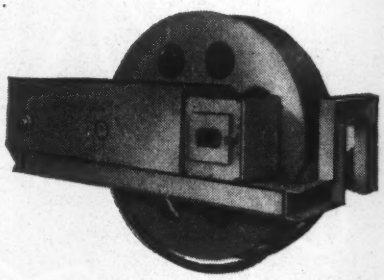
When your requirements call for an unusual motor, we can often meet your needs by modifying special designs already in production, and save you money in so doing. At an even greater saving in time and cost, we may be able to meet special needs with *standard* motors applied ingeniously to your equipment to obtain the desired results.

Ask your G-E representative for help in smoothing out any special problem involving an electric motor drive, ordinary or exceptional. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*



BUILT TO SPIN RAYON
at 10,000 rpm

For bucket spinning of heavy denier rayon for military tires, thousands of individual spindle drives are now equipped with this specially engineered ½-hp, 10,000-rpm motor. It has shown unusual ability to handle heavy rayon cakes and large unbalanced loads with minimum vibration.

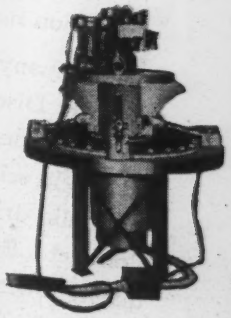


BUILT TO DO ITS BEST
at ZERO rpm

This member of a family of *stalled-torque* motors operates a reel for electric power cable on a shipyard crane, supplying the proper tension to keep the cable-slack constant while the crane is in motion. This motor is rated 20.8 lb-ft stalled torque, 514 rpm, and is of totally enclosed construction. G.E. builds stalled-torque motors in a wide variety of duty cycles, including motors that can be stalled continually.

BUILT OFF BALANCE
to shake things up

Used to operate a vibration-testing machine, this motor delivers 630 lb radial unbalanced revolving pull, 3000 to 12,000 rpm. Its shaft executes a cone-like whirling motion, which is transmitted to a structure on which instruments are mounted for test. Vibration frequency can be adjusted to duplicate patterns encountered in aircraft operation.

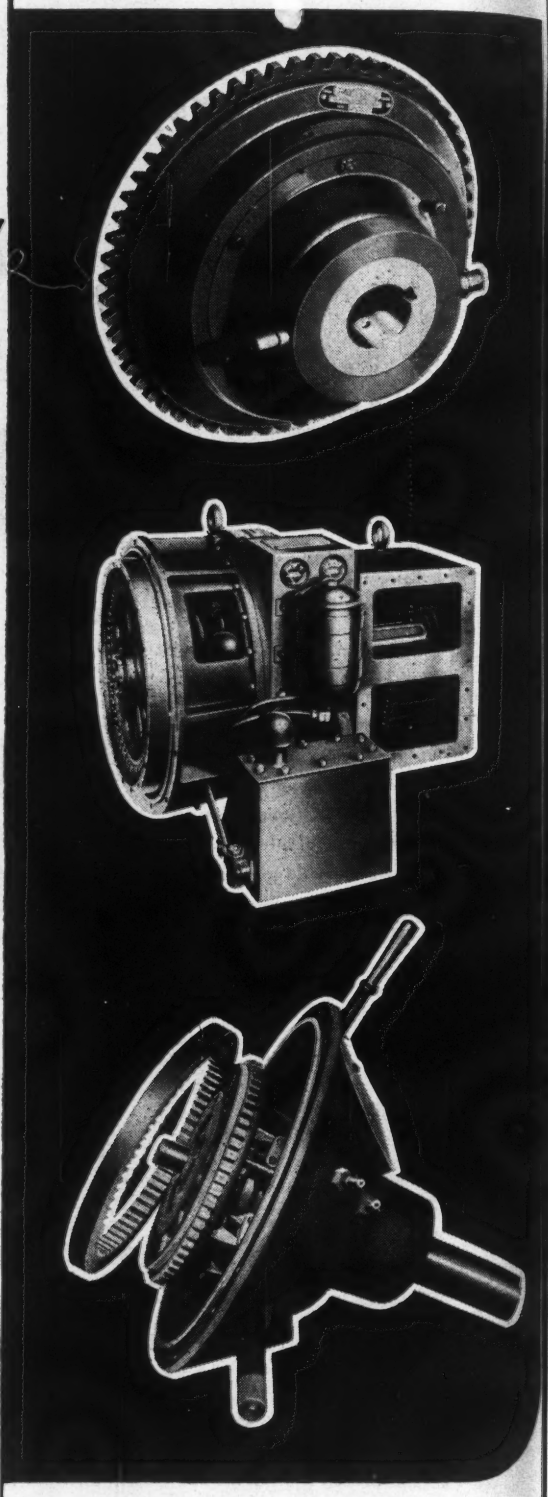


KEEP ON BUYING BONDS—
AND KEEP ALL YOU BUY

MOTOR ENGINEERING SERVICE

GENERAL ELECTRIC

A Quartet That's HARD TO BEAT



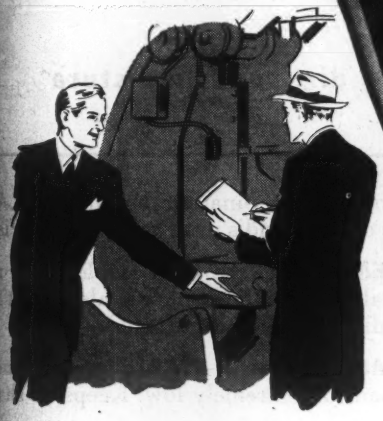
The Twin Disc Standard Line of Friction Clutches and Hydraulic Drives provides an unexcelled quartet of values:

1. *Mechanical Adaptability* covers the widest variety of industrial applications.
2. *Established Performance* is backed by well established operating records in all major industries.
3. *Assured Uniformity*, both in complete units, and replacement parts which are readily available at important industrial centers.
4. *Low Cost* is controlled by precision standards developed through over a quarter of a century of specialized clutch manufacture and modern mass production methods.

To accompany this strong quartet of advantages the Twin Disc Clutch Company offers the services of a group of field and factory engineers to aid you in selecting the correct friction clutch or hydraulic drive for your particular application. Complete Engineering bulletins await your request. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Division, Rockford, Ill.).

SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918

COUNTER-sign Your Product's Guarantee



...build-in a VEEDER-ROOT-Counting Device

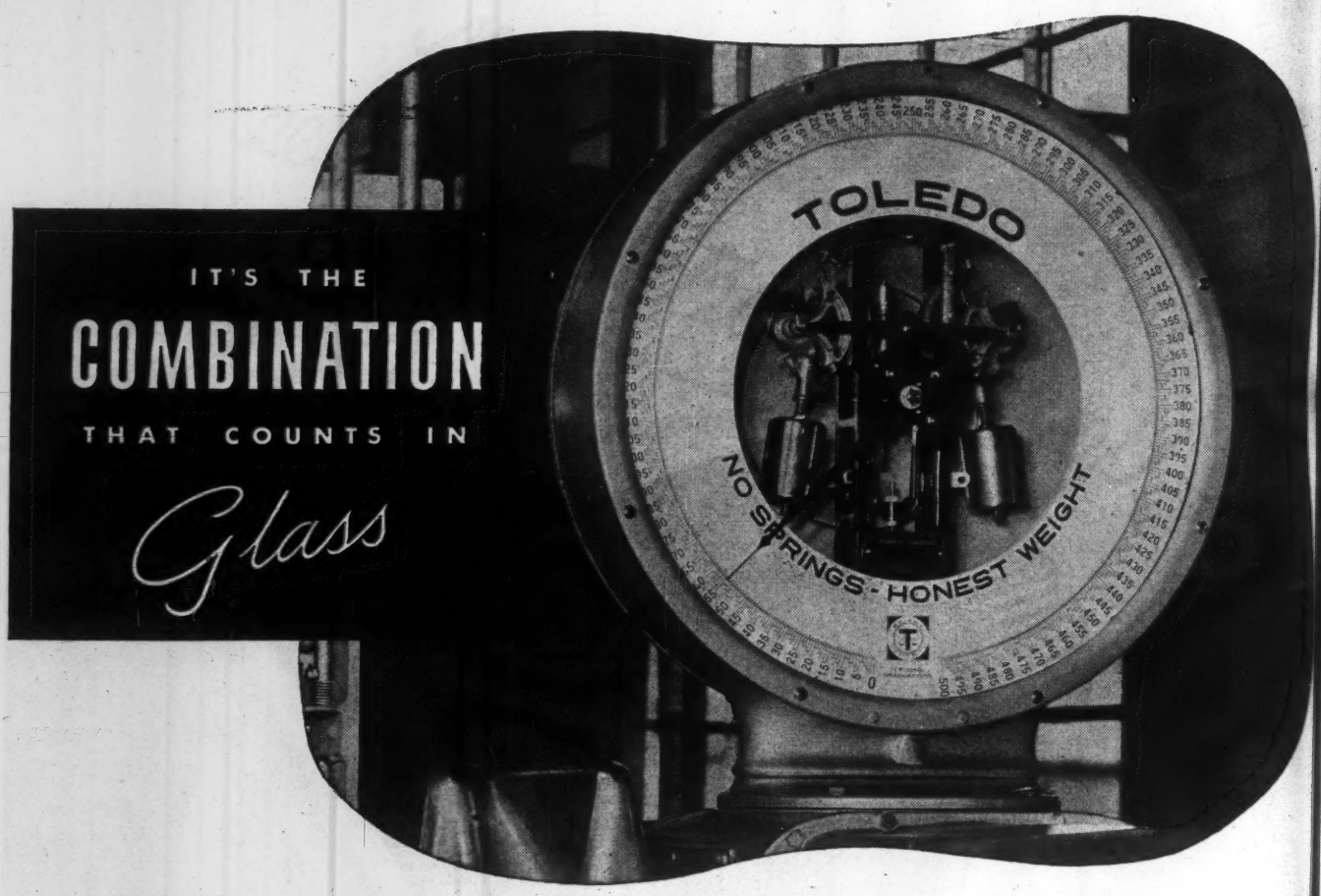
You make your product *write its own counter-signature* to your guarantee... in performance-figures that leave no room for argument . . . when you build into it a Veeder-Root Counting Device as a standard, integral part.

Then, when your product fulfills its guarantee, the Veeder-Root Counter plainly says so. For it has faithfully counted every turn, stroke, piece, trip or other performance-unit completed since your product was installed. And this evidence helps to forestall unfounded complaints and litigations, as well as loss of time, money, and customer goodwill.

Veeder-Root Devices, mechanically or electrically operated, can readily be built into any product whose performance is measured in motion or impulse . . . *from machine tools to X-ray tubes!* And even beyond this protection value, Veeder-Root Devices give you a new type of production-*Count*rol to merchandise to your markets—a potent new selling feature for peacetime competition. *Write.*

Here's how to tag your product for increased sales

VEEDER-ROOT INC., HARTFORD 2; CONNECTICUT



IT'S THE

COMBINATION

THAT COUNTS IN

Glass

Opens equipment for visibility . . . but closes it to dirt and moisture

What goes on inside? Glass lets you see.

With glass, exposure to the eye need not mean exposure to damaging dirt or moisture.

In equipment for home, store or factory, glass performs a valuable service in providing a ready answer to important questions: Is equipment working properly? What is happening to goods in processing? Is supply of raw materials still feeding in?

The agile minds of today's designers have found many ways to employ, singly or combined, the characteristics of glass . . . such as its high abrasion resistance . . . its non-porosity . . . its chemical and dimensional stability . . . its high strength when tempered . . . its weathering qualities . . . its great electrical resistance.

Glass adds beauty, too, with a lustrous, smooth, hard surface that doesn't need refinishing.

This all adds up to the fact that glass is a mighty useful, mighty versatile material. If you are planning new equipment, appliances, processes or buildings, be sure to investigate what glass can do for you. We'd welcome an opportunity to discuss it with you. Libbey·Owens·Ford Glass Company, 58125 Nicholas Building, Toledo 3, Ohio.

Here's the combination that makes GLAS one of the world's most versatile materials

CHEMICALLY, the most stable of all ma terials, except the noble metals. Won't ro oxidize or disintegrate, plus—

DIMENSIONALLY STABLE. Coefficient o expansion extremely low. Keeps its shape plus—

SURFACE, among the world's hardest an smoothest. Nonporous, won't absorb odor or moisture. More acid-resisting than an structural material. Unusual resistance t abrasion. Weathering qualities unequaled plus—

STRONG, tempered glass is stronger than some metals. A square foot, ¼" thick withstands pressure of 60 lbs. per sq. in and thermal shock of 466° F. Will no burn—

ELECTRICAL INSULATOR of outstandin strength.

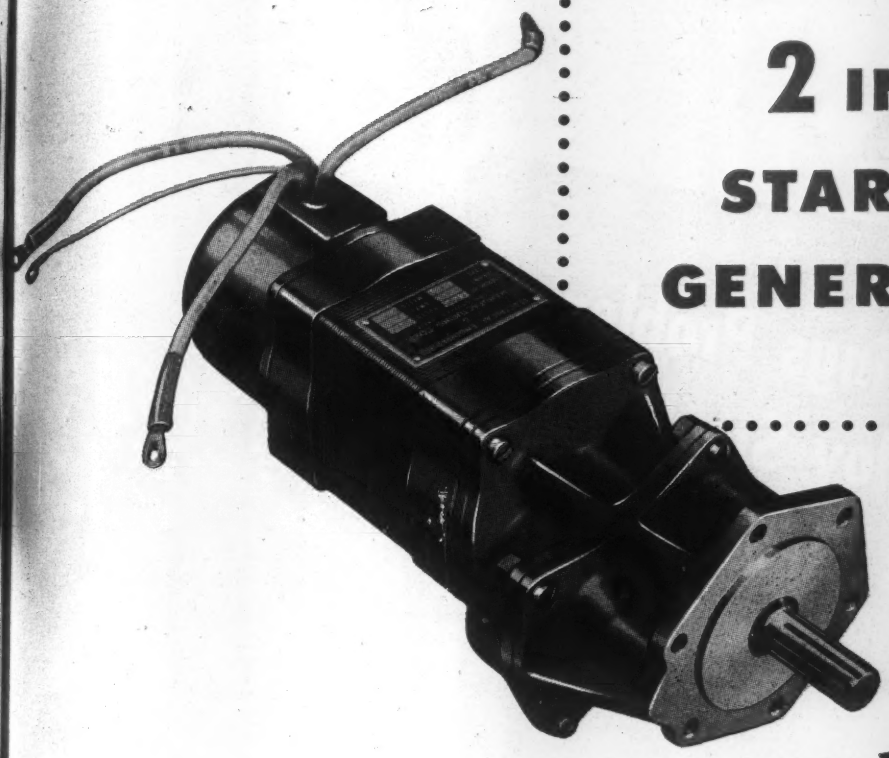
LIBBEY·OWENS·FORD

a Great Name in **GLASS**

Destructible? **Wood — Metal — Plastics — Glass. No material is indestructible. However, bear ring unforeseen conditions, no material will fail on a job in which it has been properly specified and engineered. When our application engineers say "Yes", you can be sure about glass.**

DIRECT-CONNECTED

2 IN 1 STARTER GENERATOR



SAVES GEARING

SAVES WEIGHT

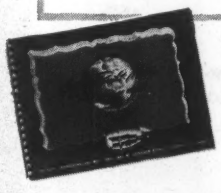
...INCREASES AIRCRAFT PAY LOADS

Here's another EEMCO special design. Separate gear-driven generators and starters can now be replaced by one *single-unit, direct-drive* starter-generator that weighs only 19 pounds. An EEMCO starter-generator on an aircraft engine can save up to 20 pounds of weight This means more gasoline (extending cruising range) or more baggage can be carried. In addition, wiring and servicing is simplified and space is conserved through the 2-in-1 design.

These sturdy units are built for long service. They have plenty of torque for starting four-cylinder engines up to 125 hp. This same torque will start even larger six- and eight-cylinder engines. As generators, they deliver 500 watts, continuous duty. A torque-limiting device built into the unit protects against damage from engine backfire. The direct connection to the engine crankshaft eliminates need for gear drives.

TECHNICAL DATA

Rated at 500 watts, for 12-, 24-, or 32-volt systems, at 50° temp. rise Maximum starting torque is 160 foot pounds. Two gear reductions incorporated in unit: 23 1 for cranking; 2½·1 for generating. Torque-limiting clutch built in. Can be fitted to most engines through available adapter mounting brackets.



Send for your copy of new EEMCO catalog . . . "Custom Built Motors for a World of Needs"— no obligation.

EEMCo

ELECTRICAL ENGINEERING AND MFG. CORP.
4606 West Jefferson Boulevard, Los Angeles 16, California

WHEN service conditions call for castings with (1) high yield point (2) low creep (3) remarkable strength (4) ability to withstand high pressures and (5) resistance to corrosion—do what leaders in the oil refining industry have done for years! Specify castings of Lebanon Circle Ⓛ 10.

General physical properties of this alloy steel are outstanding . . . weldability is satisfactory . . . and it gives excellent service at elevated temperatures.

For years, Circle Ⓛ 10 has been a standby for high pressure and other applications. It has proved its ability to withstand the corrosive action of hydrogen sulphide and other sulphur gases at temperatures up to 1100 F.

Lebanon foundry engineers and metallurgists are prepared to discuss your casting needs now. Write and tell us your requirements.

LEBANON STEEL FOUNDRY **LEBANON, PA.**

"In The Lebanon Valley"

ORIGINAL AMERICAN LICENSEE GEORGE FISCHER (SWISS CHAMOTTE) METHOD

Castings shown were cast from Circle Ⓛ 10 for hot oil refinery service. ***Top left,*** **centrifugal pump casing;** ***top right,*** **suction head for oil refinery pump;** ***center right,*** **liquid cylinder for duplex piston pump;** ***lower right,*** **bodies for high pressure valves.**

Lebanon ALLOY AND STEEL *Castings*

Hanna foot operated Valves

. . . provide simple, effortless control of air and hydraulic cylinders

HANNA Foot Valves provide quick, almost effortless control—free hands for holding work, feeding or removing pieces, and all other things that hands alone must do. Consider Hanna Foot Valves wherever possible. They will speed production, increase efficiency, reduce operator fatigue. Soundly designed for foolproof operation, sturdily built of quality materials—Hanna Foot Valves will prove a worthy part of any machine or operation where they are used . . . Write for bulletin.

Features-

1. Practically effortless action.
2. No packing to replace.
3. Easy to maintain. Pipe connections are in the base so valve may be completely disassembled without disturbing pipes or valve mounting.
4. Balanced spool. Effort to operate valve not affected by varying line pressures.
5. Inside valve parts of corrosion resistant materials.
6. All passages in the valve are full pipe size or larger.
7. Available in 3/8", 1/2", 3/4" & 1" pipe sizes.
8. For 250 P. S. I. air pressure or 1,000 P. S. I. oil pressure.
9. Sturdily constructed of quality materials for long service life.

Hanna Engineering Works

hydraulic and pneumatic equipment . . . cylinders . . . valves . . . riveters

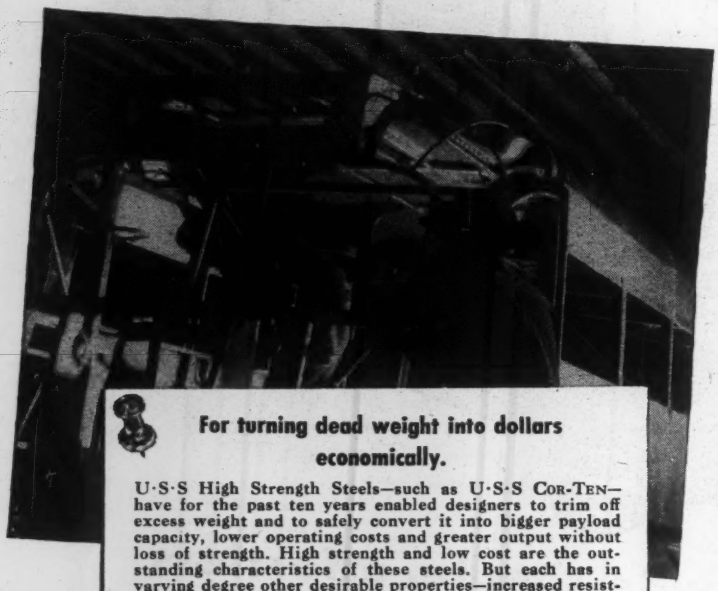
1765 Elston Avenue, Chicago 22, Illinois

What's on your drawing boards for tomorrow?

BUSES or BABY CARRIAGES

STEAM TURBINES or ELECTRIC FANS

VACUUM TOWERS or VACUUM CLEANERS



—remember... 9 TIMES OUT OF 1[0] STEEL WILL DO IT BETTER

WITH most of the advantages of steel, product designers are well familiar. But it should be kept in mind that steel's potentialities for the future have, during these war years, been greatly enhanced.

New, finer steels have been developed. Steel producing and processing techniques have been improved. Faster and more efficient methods of applying steel have been discovered. New uses for steel—either alone or in combination with other materials—have been turned up and proved practicable.

To help you in taking full advantage of the many desirable properties that steel can contribute to your postwar product that will make it more durable, more efficient, less costly to manufacture and easier to sell—the nation's largest organization of specialists in steel is ready to assist you.

CARNEGIE-ILLINOIS STEEL CORPORATION

Pittsburgh and Chicago

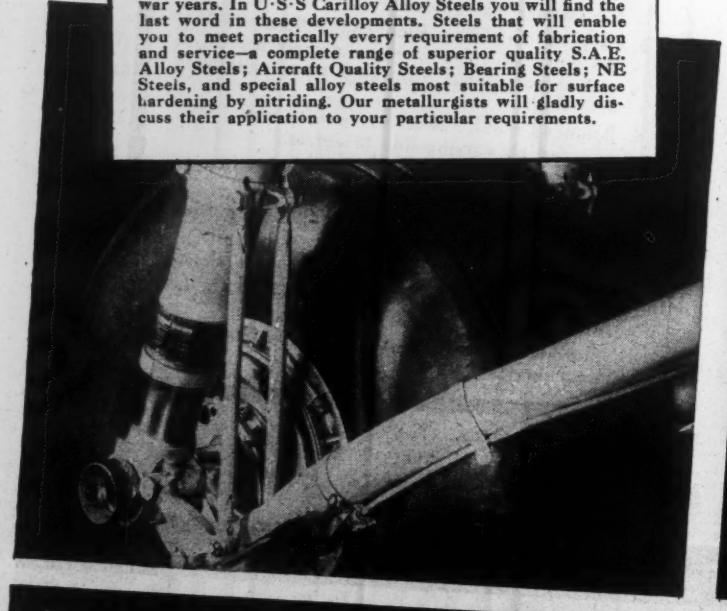
Columbia Steel Company, San Francisco, *Pacific Coast Distributors*
United States Steel Supply Company, Chicago, *Warehouse Distributors*
United States Steel Export Company, New York

For turning dead weight into dollars economically.

U·S·S High Strength Steels—such as U·S·S Cor-Ten—have for the past ten years enabled designers to trim off excess weight and to safely convert it into bigger payload capacity, lower operating costs and greater output without loss of strength. High strength and low cost are the outstanding characteristics of these steels. But each has in varying degree other desirable properties—increased resistance to corrosion, to wear, impact shock, vibration or fatigue, easy fabrication—so that the designer can obtain whatever particular combination of properties he finds most necessary for top efficiency.

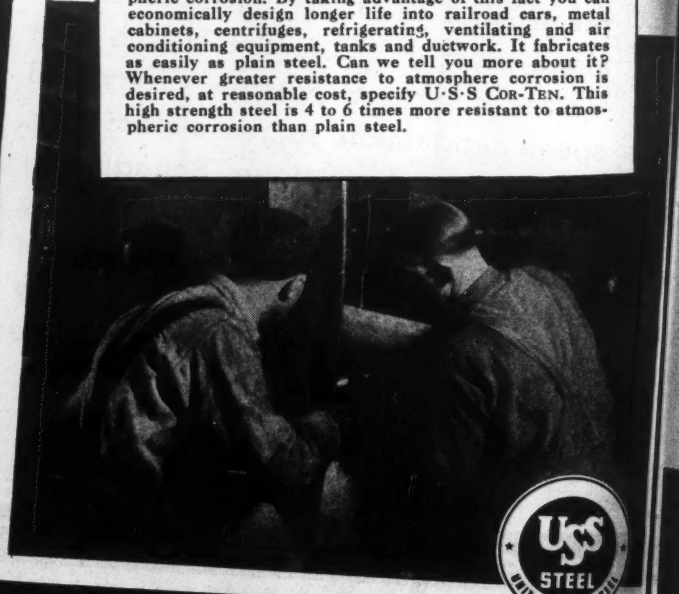
When special made-to-measure steels are needed.

What amounts to a revolution in the manufacture of steels for severe and unusual service has taken place during these war years. In U·S·S Carilloy Alloy Steels you will find the last word in these developments. Steels that will enable you to meet practically every requirement of fabrication and service—a complete range of superior quality S.A.E. Alloy Steels; Aircraft Quality Steels; Bearing Steels; NE Steels, and special alloy steels most suitable for surface hardening by nitriding. Our metallurgists will gladly discuss their application to your particular requirements.



Here's low cost resistance to corrosion.

Although it costs only about 5% more than plain steel, U·S·S Copper Steel has double the resistance to atmospheric corrosion. By taking advantage of this fact you can economically design longer life into railroad cars, metal cabinets, centrifuges, refrigerating, ventilating and air conditioning equipment, tanks and ductwork. It fabricates as easily as plain steel. Can we tell you more about it? Whenever greater resistance to atmosphere corrosion is desired, at reasonable cost, specify U·S·S Cor-Ten. This high strength steel is 4 to 6 times more resistant to atmospheric corrosion than plain steel.



USS STEEL

UNITED STATES STEEL

Pesco GENERAL PURPOSE HYDRAULIC PUMP

It's tiny, but packed with power . . . this NEW General Purpose Hydraulic Pump by PESCO. It fits the palm of your hand with ease . . . yet it develops pressures up to 1,500 p.s.i. Superior design gives this pump unusually high volumetric efficiencies—95% and better at 3,000 r.p.m. at 1,500 p.s.i. And, small as it is, it features *Pressure Loading*, the exclusive PESCO development that *automatically* maintains minimum clearance between pump gears and gear housing, making possible continuous high operating efficiencies over a wide range of temperature variations and speeds.

The possible uses of this NEW PESCO General Purpose Hydraulic Pump cover numerous industrial applications. Its sturdy, yet simple construction assures a long life of trouble-free operation. Other models available for pressures up to 3,000 p.s.i. Write for Bulletin No. 101 and other descriptive literature on hydraulic pumps. PESCO Products Co. (division Borg-Warner), 1610 Euclid Avenue, Cleveland 6, Ohio.

In Precision Hydraulics, Fuel Pumps, Air Pumps, Related Accessories . . .
PERFORMANCE POINTS TO Pesco FIRST

For Blue Ribbon Blueprints

If awards were being given for blueprints of outstanding excellence, those made with Arkwright Tracing Cloth would certainly be in the Blue Ribbon class! Arkwright cloths contain no surface oils to become opaque and brittle with age. Exceptionally high, longer lasting transparency is obtained by Arkwright's exclusive mechanical processing methods.

EASES AND SPEEDS WORK. You'll find no pinholes, specks, dirt, stains or other imperfections to detract from its use as a drawing material or lower the quality of your reproductions.

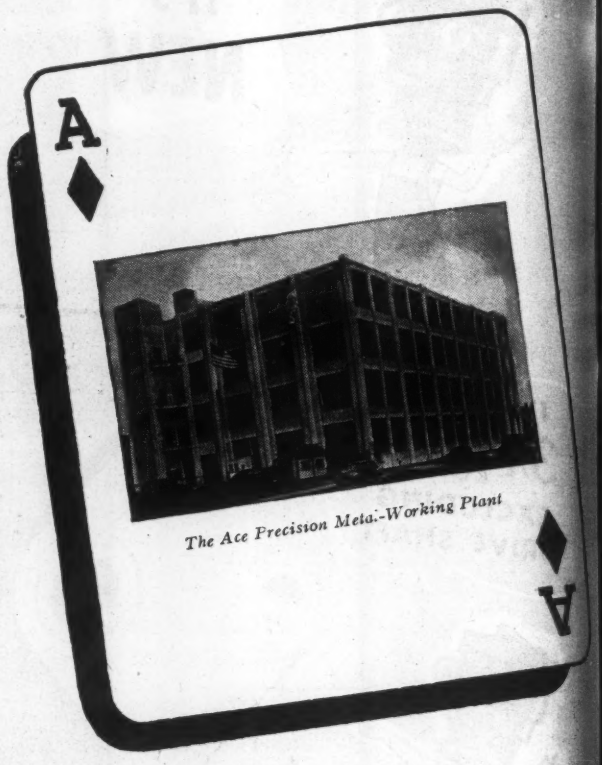
TOUGH AND SERVICEABLE. Arkwright Tracing Cloths take erasure after erasure without smudging or wearing through. And re-inking is done without "feathering" or blotting. Countless copies can be made without tearing, fraying or curling of the original drawing.

FREE SAMPLES. Samples of this work-easing, job-improving cloth will be sent free on request to test on your own drawing board. Write: Arkwright Finishing Company, Providence, Rhode Island.

Sold by leading drawing material dealers everywhere

Arkwright
TRACING CLOTHS
AMERICA'S STANDARD FOR OVER 20 YEARS

PRECISION PARTS



The Ace Precision Metal-Working Plant

HERE'S THE ACE UP YOUR SLEEVE FOR POST-WAR

Is progress on your post-war products held up thru lack of facilities for dies, tools, stamping, heat treating, machining, grinding or assembling? Let ACE help you speed your much-wanted new products to market.

Here under one roof are the ingenuity and modern equipment to help you design that product of yours . . . make the necessary tools and dies . . . and put it into production. Furthermore, on certain products, we have a complete sales and merchandising staff to put it on the market, if you so desire.

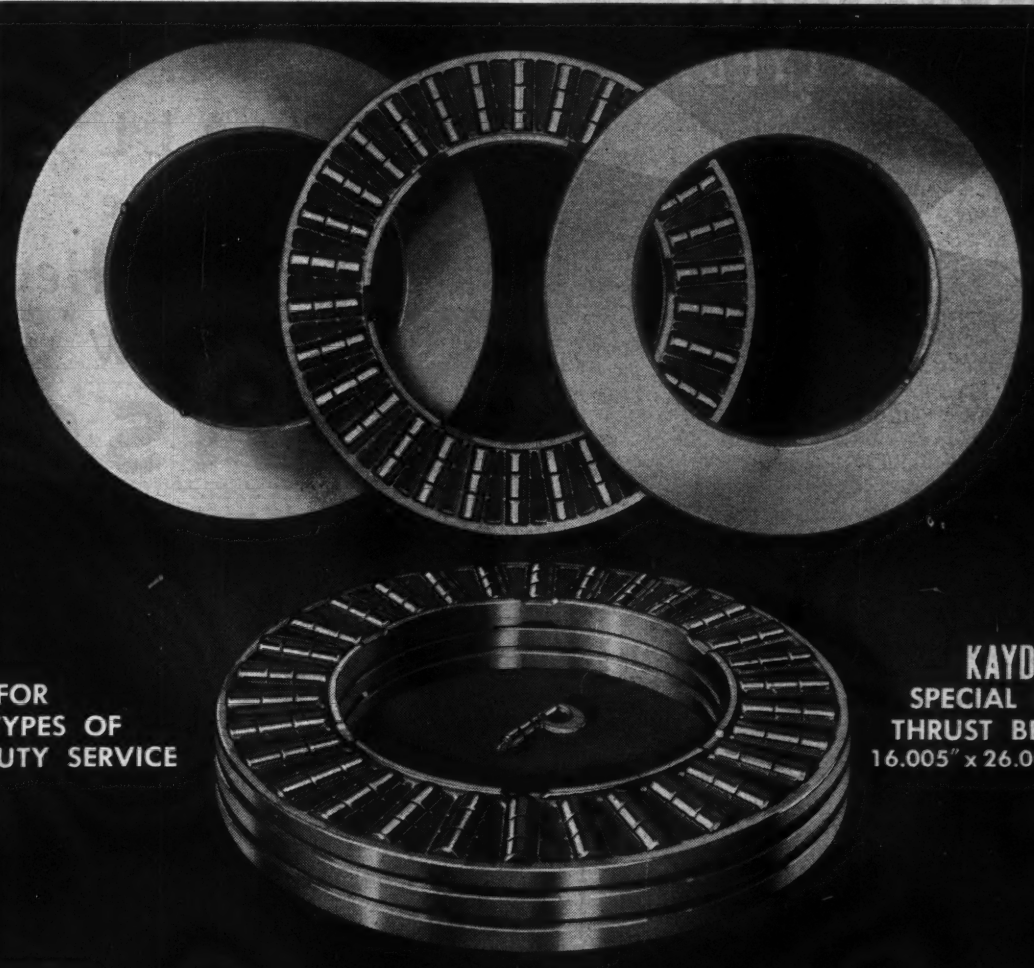
As a veteran of World War II on the production-front and three-time winner of the Army-Navy "E" Award, Ace has acquired the knack of machining delicate parts to incredible accuracies—and doing it fast, on a mass-production basis. In terms of peace-time production, this speed-with-accuracy offers important competitive advantages. Have an Ace up your sleeve. Plan with Ace now.

ACE
TRADE MARK

ACE MANUFACTURING CORPORATION
for Precision Parts
1201 E. ERIE AVE., PHILADELPHIA 24, PA.

Contact KAYDON *of Muskegon*

FOR ALL TYPES OF BALL AND ROLLER BEARINGS 4" BORE TO 120" OUTSIDE DIAMETER



FOR
ALL TYPES OF
HEAVY-DUTY SERVICE

KAYDON
SPECIAL ROLLER
THRUST BEARINGS
16.005" x 26.000" x 3.500"

KAYDON *Scientific Hardening Processes Advance Precision*

YOU can depend on **KAYDON** bearings to have proper surface finish characteristics and load capacity for the type of bearing duty required.

KAYDON engineering and production controls, including the most scientific hardening and conditioning processes, assure peak precision performance in ball and roller bearings in any required size within the complete range of 4" bore to the extremely large 120" O. D. bearings.

KAYDON Ball and Roller Bearings are engineered and produced entirely within the **KAYDON** plants, to meet the most exacting requirements of modern precision machines and heavy-duty machinery used in paper mills and steel mills, oil field equipment, cranes, hoists, crushing and excavating machinery, and other equipment that will mean so much to America's future industrial leadership.

Counsel in confidence with KAYDON. Capacity is available now for production of all types and sizes of KAYDON Bearings. In addition, KAYDON also offers complete facilities for atmospheric-controlled heat treating, precision heat treating, salt-bath and sub-zero conditioning and treatment, microscopy, physical testing and metallurgical laboratory services. Plan now with KAYDON.

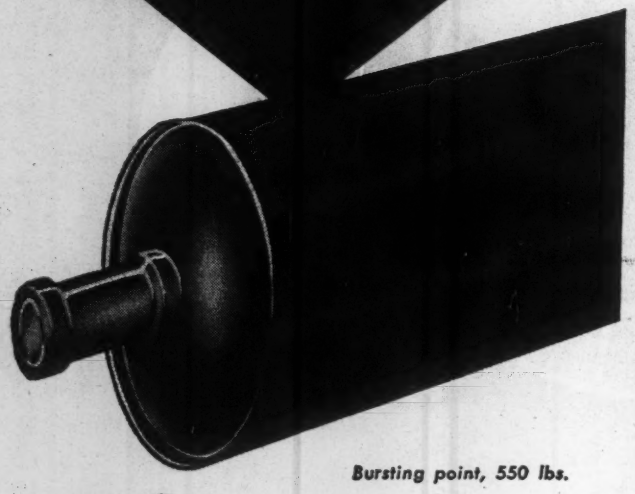
KAYDON *Types of Standard or Special Bearings:*
Spherical Roller • Taper Roller
Ball Radial • Ball Thrust
Roller Radial • Roller Thrust

THE KAYDON ENGINEERING CORP.

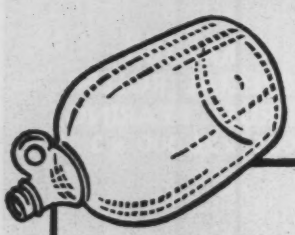
MUSKEGON • MICHIGAN

New in Name . . . Old in Experience

Can You Use CYLINDERS OF THIS TYPE?



Bursting point, 550 lbs.



SEAMLESS CYLINDERS like the dryers used in paper mills for drying paper.

SEAMLESS CYLINDERS with unbored inner walls, like inner walls of a bottle—all the rust-resisting inner wall silica film still intact.

SEAMLESS CYLINDERS without bolted-in heads. One piece journals cast integral.

SEAMLESS CYLINDERS up to 60" diameter and 240" length.

SEAMLESS CYLINDERS built to carry up to 200 lbs. pressure. Meet all code requirements.

If interested, drop us a line.

THE BLACK-CLAWSON CO.

HAMILTON, OHIO

Divisions: Shartle Bros. Machine Co., Middletown, Ohio

Dilts Machine Works, Fulton, N. Y.

ALL *of the* *French & Hecht* NEW

DISC WHEELS

are REVERSIBLE *and* SELF-LOCKING

Catalogs are not immediately available but individual selection will be made to fit your requirements on request.

FRENCH & HECHT, INC.

SUBSIDIARY OF KELSEY-HAYES WHEEL CO.

DAVENPORT, IOWA

"Impossible" is a word that is not recognized by engineers. To dam a mighty river, tunnel under it or suspend a bridge across it—things such as these that once seemed pure imagination were made possible by instruments devised to refine and extend human faculties, to translate the precision of engineering thought into action.

Keuffel & Esser Co. is proud to have played so large a part in making such instruments widely available. In this way K & E equipment and materials have been partners of the engineer and draftsman for 78 years in shaping the modern world. So universally is this equipment used, it is self-evident that K & E have played a part in the completion of nearly every engineering project of any magnitude. Could you wish any surer guidance than this in the selection of your own "partners in creating"?

Not only for construction and building, but for setting up precision machine tools and long production lines, in the fabrication of large ships and aircraft, experienced engineers know that they can rely utterly on K & E transits and levels. Coated lenses for increased light transmission, precision-ground adjusting screws, chromium-coated inner center and draw tubes, completely enclosed leveling screws, improved achromatic telescopes—all these typify the advanced design of these instruments.

partners in creating

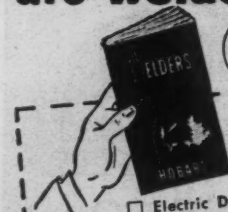
reduce production costs

...design for simplified arc welding—

You owe it to yourself to try Hobart "Simplified" Arc Welding, because of the enviable record it established in the production of war materials. This same speed-up production method can be used to advantage in producing materials for peace . . . especially if you're in a highly competitive field and manufacturing products from metal. Let us show you with "Practical Design for Arc Welding," how easy it is to design and redesign for arc welding . . . and how you can increase your profits by the Hobart "Simplified" Arc Welding method. Just return the handy coupon below for complete details!

Hobart Bros. Co., Box MD-125
Troy, Ohio

Hobart "Simplified" arc welders



Hobart Brothers Co., Box MD-125, Troy, Ohio
Please send me information on items checked. Also, tell how to get "Practical Design for Arc Welding."
FREE! Welders' Vest Pocket Guide ☐ Check here!

☐ Electric Drive Welder
☐ Generator Only
☐ Gas Engine Drive Welder
☐ A.C. Transformer Welder

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GIVE YOUR PRODUCT Standout IDENTIFICATION

The battle for the consumer's dollar now shaping up promises to be the hottest in history!

When you've given your product the best in design, engineering and quality, give it one thing more to set it apart from competition

—give it standout identification with a fine looking Ecoa name plate.

Ecoa name plates, etched or lithographed

ECOA *Name Plates*

on metal, in colors as desired, spotlight your product. Ecoa name plates look better—longer. They're worthy marks for worthy products.

Write now for quotations, without obligation. Our art department will help on design if you desire.

ETCHING COMPANY OF AMERICA

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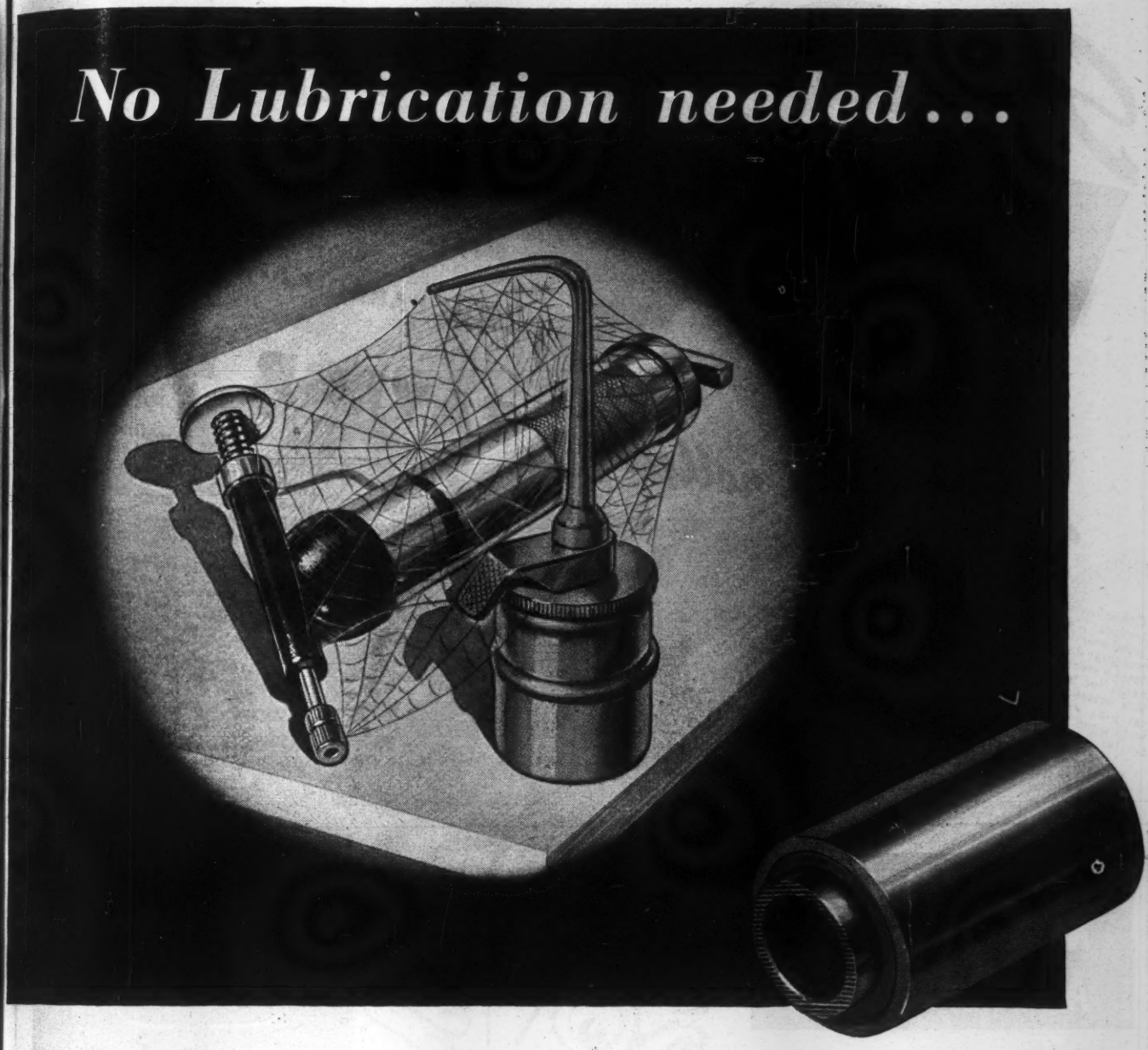
Metal Name Plates, etched or lithographed • Plastic Name Plates, Dials and Panels, lithographed or screened • Etched Metal Scales, Clock Dials, Instrument Panels, Art Novelties, Advertising Specialties • Etched Metal Panels for elevators and architectural uses.

SUBSIDIARY OF DODGE MFG. CORPORATION, MISHAWAKA, INDIANA

No Lubrication needed...



...if your product has Silentbloc Torque Bearings

IF you are seeking a basic improvement for equipment that works with torque action or oscillation, this is it—*The General Silentbloc Rubber Torque Bearing.*

Check the selling points added to your product by Silentbloc bearings:

No lubrication; no spoilage from dripping oil. Unaffected by grit, dust, oil, water or gases. Silent operation. Long, trouble-free life.

No other rubber bearing matches the efficiency of the Silentbloc. The patented construction — enlongating rubber at high speed between metal sleeves—gives non-slipping adhesion and even distribution of compressive stress, vital for long life.

General engineers can help you design a Silentbloc bearing for your specific needs in amplitude and operating conditions. Silentbloc bearings can be made in any size, using any metal and rubber. They are simple to design into your product and easy and economical to install.

For full information, write for booklet on Silentbloc Bearings, Mountings and Bushings; or see Silentbloc Section in Sweet's Product Designers File. The General Tire & Rubber Co., Dept. 175, Wabash, Indiana.

Patented Silentbloc principle of elongating and confining rubber between metal members produces a virtually indestructible adhesion and uniform stress, resulting in precise performance and long life.

The GENERAL SILENTBLOC
MOUNTINGS . . . BEARINGS
COUPLINGS

Mechanical Goods Division, Wabash, Ind.

THE GENERAL TIRE & RUBBER CO.

Makers of America's Top-Quality Tire

Seamless RINGS

...IN CARBON AND ALLOY STEELS

Forged and rolled by TAYLOR FORGE

The Taylor Forge plant houses the finest forging, rolling and machining equipment for producing extremely accurate rings in sizes from 12" O.D. to 120" O.D. When special characteristics are required, complete facilities are available for heat treating guided by a modern testing laboratory for verifying results.

More than forty years of experience in forging and rolling seamless annular products is your guaranty that your requirements for forged and rolled rings will be better handled here.

Other Taylor Forge Products include: "Weldells" and related seamless fittings for pipe welding; forged steel flanges; forged steel nozzles and welding necks for boiler and other pressure vessel outlets; light wall spiral pipe and heavy wall electric-weld pipe; corrugated furnaces, and similar forged and rolled products.

TAYLOR FORGE & PIPE WORKS

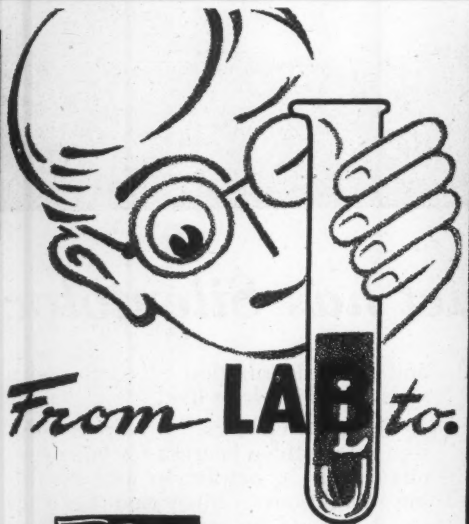
General Offices & Works: Chicago ... *New York Office:* 50 Church Street • *Philadelphia Office:* Broad Street Station Bldg.

IMPROVED Machining of ALLOY STEELS

The machinability of Alloy Steel is developed to a new high level by the addition of a slight amount of sulphur to the ladle of molten metal.

This improvement is in addition to that obtained through the development of suitable structure by proper furnace treatment.

Such an advance in steel making offers new opportunities to users of Cold Finished Alloy Bars. Ask your local distributor for further details about B&L . . .



From LAB to.. LADLE

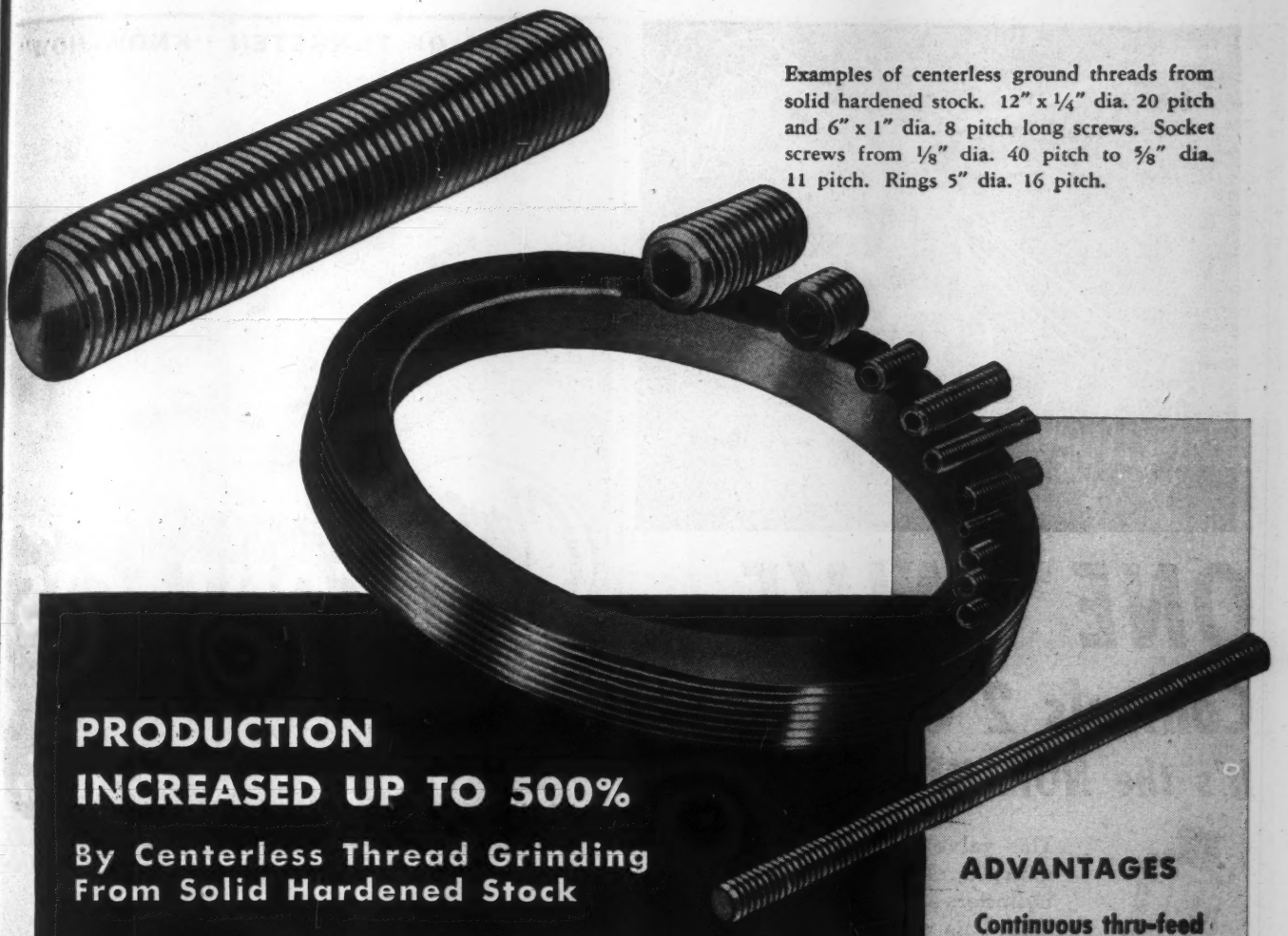
ARMY E NAVY

Keep buying Victory Bonds—and keep all you buy.

COLD FINISHED STEEL AND SHAFTING

BLISS & LAUGHLIN, INC.

HARVEY, Ill. BUFFALO, N. Y.



Examples of centerless ground threads from solid hardened stock. 12" x 1/4" dia. 20 pitch and 6" x 1" dia. 8 pitch long screws. Socket screws from 1/8" dia. 40 pitch to 5/8" dia. 11 pitch. Rings 5" dia. 16 pitch.

PRODUCTION INCREASED UP TO 500%

By Centerless Thread Grinding From Solid Hardened Stock

The new LANDIS TOOL Centerless Thread Grinder makes practical for the first time, large volume production of ground threads to highest precision standards.

In actual production of commercial socket set screws, there have been increases as high as 500% per day.

Once set up, an automatic loader requires only intermittent attention. Spot checking of thread form eliminates need for 100% inspection. Rejects are almost entirely eliminated because the wheel is recrushed when it shows signs of wear. Time out for reforming is kept to a minimum with the built-in crusher.

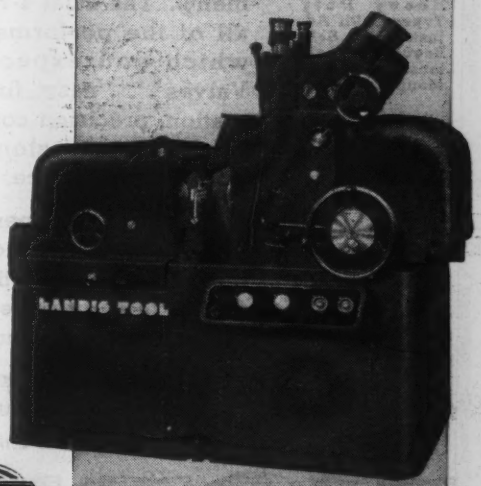
The high production of the LANDIS TOOL Centerless Thread Grinder also makes possible substantial cost reductions. Figures on some sizes show reductions up to 80%. In addition, the resulting thread is better looking, smooth, bright, free from burrs as well as stronger, because of freedom from heat treatment warpage and cracks.

Our engineering department will be glad to make recommendations on your centerless thread grinding problems.

27A

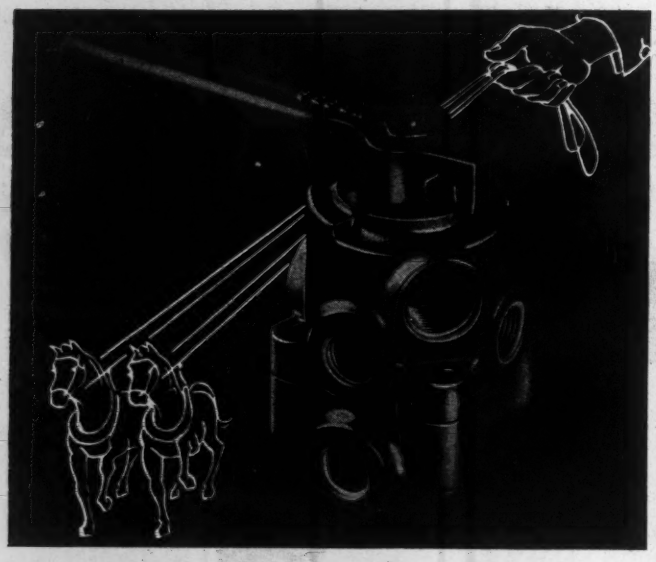
ADVANTAGES

- Continuous thru-feed
- Fewer rejects
- Less inspection
- Less downtime
- Bright finish
- Smooth surface
- No heat treating distortion
- Automatic loader



LANDIS TOOL *Precision Grinders*

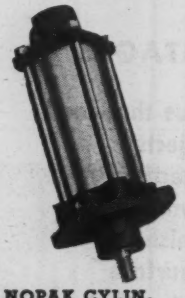
LANDIS TOOL CO., WAYNESBORO, PA.



ONE VALVE

Controls 2 Cylinders...

It's the NOPAK* Dual 4-Way!



NOPAK CYLINDERS — for Air or Low Pressure Hydraulic Power, available in Standard and Heavy Duty Types, with Adjustable or Self-Requlating Cushions. 6 Standard Mountings.

This valve has proven its merit in many applications in which dual cylinders are used in close relationship. This valve is so designed that two cylinders may be actuated in either direction, in any sequence desired.

A variety of operating cycles may be set up . . . and governed by a single control lever. This is a decided advantage in manipulating inter-dependent machine movements. The Dual 4-Way embodies all of the performance features which you expect of NOPAK Valves . . . easy, finger-touch operation, precision control, freedom from grit abrasion, long-lived, trouble-free service.

*At present the NOPAK Dual 4-Way Valve is available in one size only, which may be used on pipe lines ½" or smaller.

To machine designers, the NOPAK Dual 4-Way, provides a simple means of coordinating two inter-dependent cylinder movements for greater operating efficiency.

GALLAND-HENNING MFG. CO.
2752 S. 31st STREET MILWAUKEE 7, WISCONSIN

Representatives in Principal Cities

NOPAK

VALVES AND CYLINDERS

DESIGNED for AIR and HYDRAULIC SERVICE

A 4872-½A

25 YEARS OF TUNGSTEN "KNOW-HOW"

Cleve-Tung CONTACTS FOR *Exacting Requirements,*

Especially Parallel Face and Close Tolerance Discs

"Cleve-Tung" tungsten contacts for ignition and other electrical applications are made from highest purity ores. Processing is controlled by microscopic and spectroscopic analyses. Uniformity and control of grain size are insured by these methods. "Cleve-Tung" contacts represent over 25 years of "know-how". We specialize in manufacture of discs requiring very close tolerances and parallel faces. You may have plain, polished, or radius-ground contacts to fit your individual specifications.

★ ★ ★

Ask for Bulletin "D"

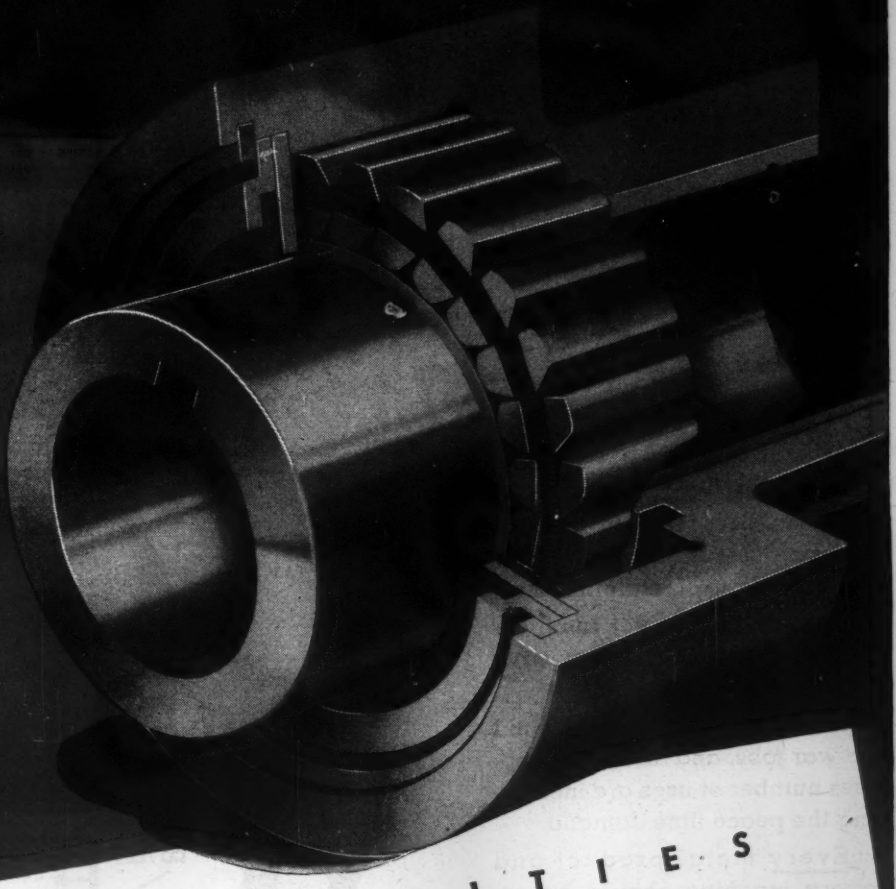
CLEVELAND TUNGSTEN, INC.
10200 MEECH AVENUE • CLEVELAND, OHIO

Cleveland Tungsten has always manufactured all its tungsten products, including metal powder, rod, contacts and electrodes

FORMSPRAG

THE FULL COMPLEMENT

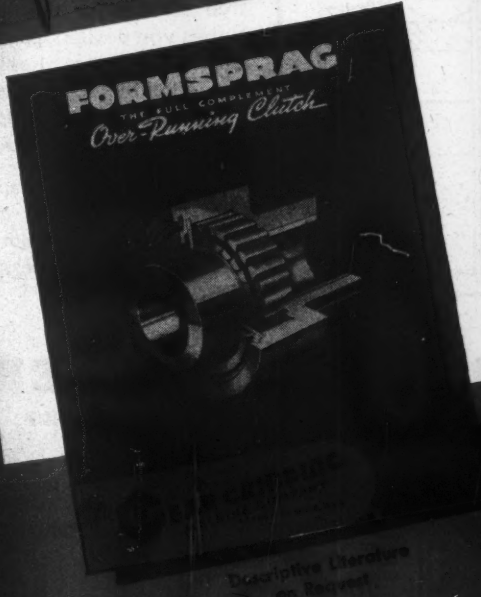
Over-Running Clutch



Formsprag has an extremely high torque capacity. It is compact, simple and rugged. It is instantaneous in action, without lost motion or backlash, and over-runs freely on the slightest reduction in speed of the driving member.

Torque is applied by the gripping action of a large number of energized sprags that completely fill the annular, cylindrical space between the driving and driven members. There are no external or internal cam surfaces—no spots where localized wear can develop.

All sprags are hardened, with contours accurately form-ground to a shape that insures positive, non-slipping driving action, quick release and long life.

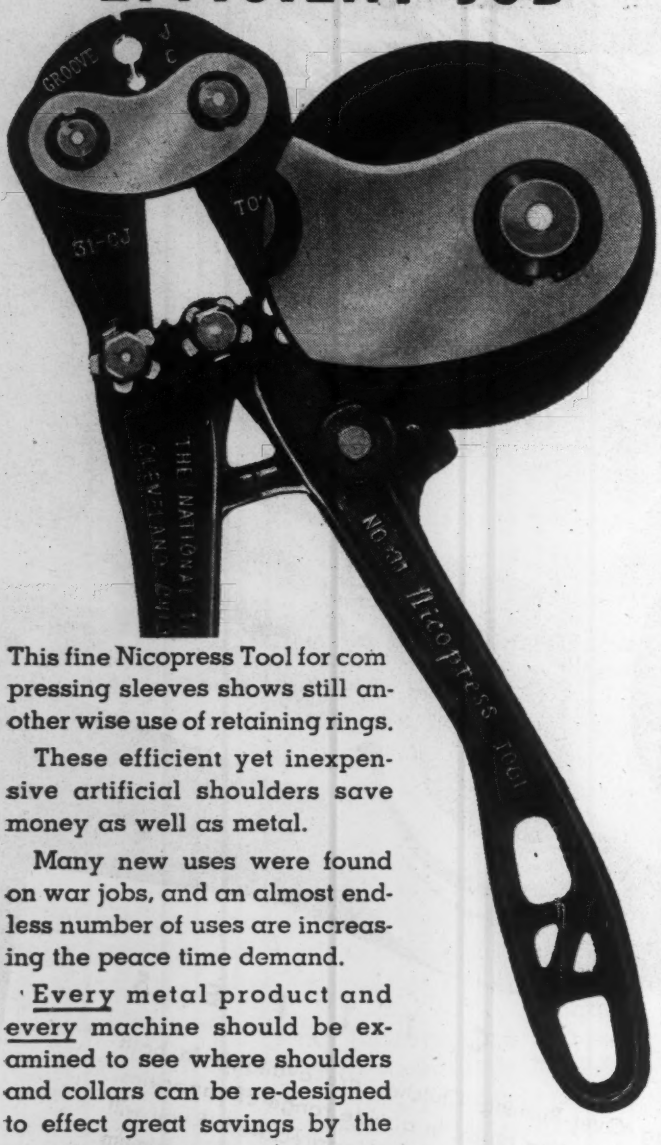


CAPACITIES

● Formsprag Over-Running Clutches are available in both plain and ball bearing types, in a wide range of capacities. When writing for literature, it will be appreciated if you will send a description of the operation, normal and maximum torque at specified speeds, number of times per minute the clutch engages and disengages, and other pertinent information.

The GEAR GRINDING MACHINE COMPANY
DETROIT 11, MICH. U.S.A.

NATIONAL RETAINING RINGS DO ANOTHER EFFICIENT JOB



This fine Nicopress Tool for compressing sleeves shows still another wise use of retaining rings.

These efficient yet inexpensive artificial shoulders save money as well as metal.

Many new uses were found on war jobs, and an almost endless number of uses are increasing the peace time demand.

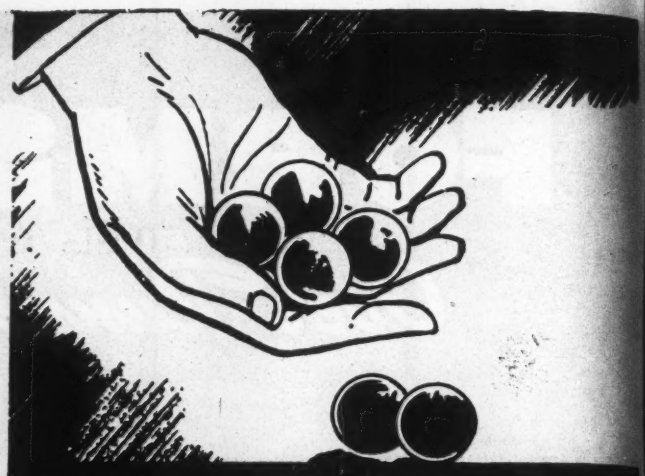
Every metal product and every machine should be examined to see where shoulders and collars can be re-designed to effect great savings by the use of retaining rings.

It's expensive to hold a mechanism in place with unnecessarily big shoulders or collars,—or to temporize with small cotter pins, etc.

Let us show you how steel retaining rings can do a thoroughly efficient job for you,—saving you time, money and metal.

Our booklets describe many types. Write today.

THE NATIONAL LOCK WASHER COMPANY
Newark 5, New Jersey — Milwaukee 2, Wisconsin

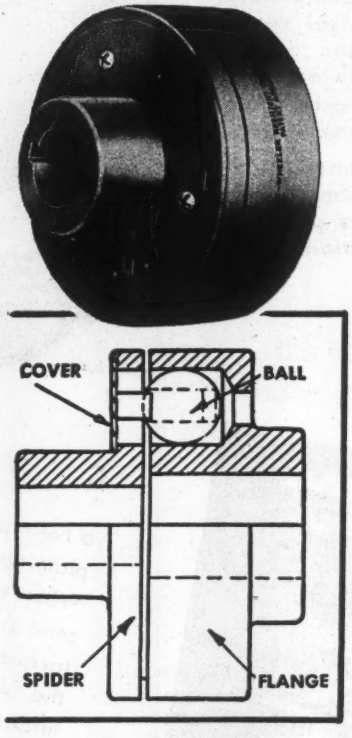


THESE 6 RUBBER BALLS

will *prolong the life* of your machine

They are the transmission elements of a Crocker-Wheeler Resilient Flexible Coupling. Made of synthetic rubber composition, they transmit the torque, absorb shock and vibration, yet do not transmit end thrust.

If serious misalignment occurs after installation, neither the connected machines nor the coupling will be harmed. The only damage will be to the rubber balls, which can be replaced at negligible cost, in one or two minutes. Under normal service conditions the balls last for many years without renewal. The coupling requires no lubrication, no maintenance of any kind.



To assure long, trouble-free service for the machines you design, specify Crocker-Wheeler Resilient Flexible Couplings. They are available for shaft diameters up to 8".

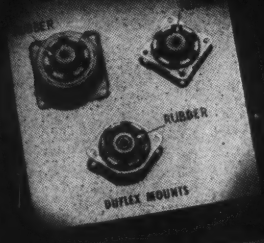
Write on your company letterhead for prices, dimensions and descriptive information. No cost, no obligation.

CW-11

CROCKER-WHEELER
A Division of JOSHUA HENDY IRON WORKS
AMPERE 22, NEW JERSEY

BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • LOS ANGELES
DETROIT • NEW YORK • PHILADEPHIA • PITTSBURGH • SAN FRANCISCO • WASHINGTON

Torflex Flexible BEARINGS
HARNESS VIBRATION AND NOISE



● Three of the most destructive enemies moving parts have to contend with are vibration, noise and shock. They impair smooth operation, cut down efficiency, produce excess wear and shorten the life of any piece of equipment. Torflex Flexible Bearings were created, engineered and designed to control and eliminate vibration, noise and shock and are manufactured by Harris Products Company, pioneers in the field of engineered vibration control.

Torflex Flexible Bearings consist of a tube or ring of rubber stretched longitudinally between two concentric metal sleeves which prevent the rubber from returning to its original state. The pressure thus exerted by the rubber, on the metal sleeve, insures a high capacity mechanical bond between the rubber and metal under all operating conditions. Torflex Flexible Bearings are free from wear, also have long life, compensate for parallel and angular shaft misalignment, require no lubrication, and are widely used to transmit torque. They come in a wide range of sizes, are simple and easy to incorporate in designs and to install.

We welcome the opportunity to discuss with engineers and manufacturers the possibilities and the many advantages of Torflex Flexible Bearings in the control and elimination of vibration, noise and shock. Drop us a line today.

HARRIS
PRODUCTS COMPANY
CLEVELAND 4, OHIO

MORE *Engineering* DATA on

BALDOR GLASS INSULATED MOTORS

The better the insulation, the better the motor

BALDOR, the Better Motor, is made even better by the use of GLASS INSULATION because —

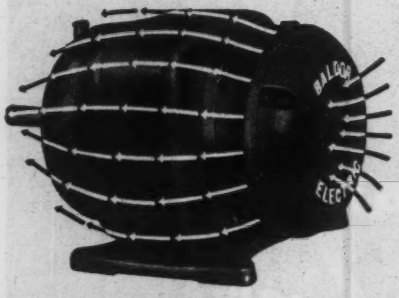
Glass insulation withstands HIGHER TEMPERATURES—as high as 250° C. as compared with 95° C. critical limit for cellulose insulation. Result, less chance for break-down.

Glass insulation makes possible MORE COMPACT, LIGHTER WEIGHT motors. (For example: 10 H. P. motors in standard 7½ H. P. frames . . . and with 135 lbs. LESS WEIGHT.)

Glass insulation is non-hygroscopic — the dielectric strength remains almost as high in humid or damp surroundings as in a dry atmosphere.

Being inorganic, glass insulation does not rot nor deteriorate even when constantly exposed to dampness.

May we tell you more about these BALDOR Better Motors?



Above: BALDOR STREAMCOOLED MOTOR, totally enclosed. Arrows indicate air travel over ENTIRE EXTERIOR of motor.

BALDOR ELECTRIC COMPANY

General Offices: ST. LOUIS 10, MO. • *District Offices in Principal Cities*

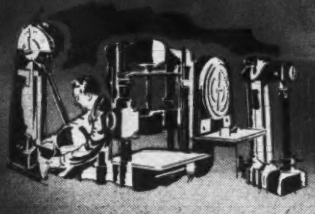
PLAN YOUR POST-WAR MOTOR REQUIREMENTS ***Now.*** Get the Latest BALDOR Bulletins

WANTED:

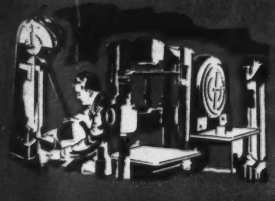
Mechanical Engineer

. . . with writing ability and actual experience in design of machines. Salary open. Excellent opportunity in editorial capacity for man with suitable qualifications. Write Box 470, MACHINE DESIGN, Penton Building, Cleveland 13, Ohio.

IN *Forgings* YOU GET MAXIMUM METAL QUALITY *Plus These Advantages*



1. High tensile and impact strength obtained through controlled concentration of grain structure and fibre-like flow lines.



2. A correctly proportioned combination of physical properties to meet a specific service condition.

3. Reduction of dead weight; maximum strength and toughness in lighter cast steel structures.

3. Rapid assembly of complex parts by welding, because forgings provide welding adaptability of widest range.

4. Reductions in cost at point of assembly due to less time required to machine and finish, and fewer rejects.

7. Controlled concentration of fibre-like flow line structure of metal at points of greatest shock and stress.

6. A reduction of accidents to men and machines because forgings provide a greater margin of safety.

Forging metals in closed impression dies develops maximum metal quality. A product fortified with the metal quality found in forgings outperforms other products. A recheck of every stressed part whether of simple or complex design, against the seven advantages that forgings offer may reveal the possibility of further strengthening a part or a product to give longer service life; to lessen weight; to reduce the cost of machining and finishing; to speed up assembly. Consult a forging engineer connected with your source of supply about the wide range of combinations of quality advantages that are available in forgings, and how you can obtain metal quality in the exact degree required for a specific condition. Forging techniques required to forge so-called "impossible-to-forge-designs" are now available for the production of peacetime forgings.

DROP FORGING ASSOCIATION

605 HANNA BUILDING • CLEVELAND 15, OHIO

DROP FORGING ASSOCIATION
605 Hanna Building • Cleveland 15, Ohio

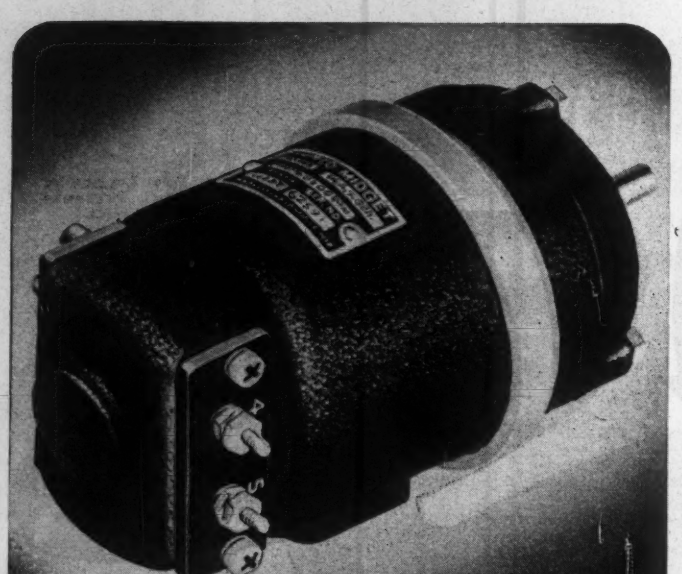
☐ Booklet on "Metal Quality—Hot Working Improves Properties of Metal."

☐ "Drop Forging Topics," issued ten times a year.

Name ..... Position .....

Company .....

Address ..... City ..... State .....



New TYPE "FB" ELINCO MIDGET PRECISION FRACTIONAL H.P. Motors and Generators

Type FB units are newly engineered to meet most exacting requirements for fractional horsepower motors and generators. Available as D.C. permanent-magnet generators or motors, D.C. shunt-wound, series-wound or split-field motors. D.C. motors can be wound to operate on voltages from 6 to 115 v. Also available in A.C. types as permanent-magnet generator wound to generate 2-pole single phase, 2 phase or 3 phase; as A.C. series motor with power supply up to 115 v., 60 cycles, single phase; also as universal series motor up to 115 v. Efficiency of motors as high as 45-60% on some applications.

Stainless steel shafts, aluminum die-cast housing finished in baked enamel. Overall dimensions 4" long (exclusive of shaft) by 2½" over flange. Designed for either base or flange mounting. Weight from 26 to 32 oz. according to type. Complete performance data available on request.

Write for Catalog FB

ELECTRIC INDICATOR CO.

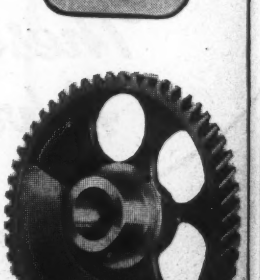
108 Parker Ave., Stamford, Conn.

MAY WE REMIND YOU

- ★ SPUR
- ★ BEVEL
- ★ HELICAL
- ★ SPLINE
- ★ WORM
- ★ SPECIAL

that to meet the challenge of Post War competition your product must have new standards of efficiency, usefulness and durability. We can assure you that the use of Cincinnati *Gears, Good Gears Only* will make this possible.

Their inherent qualities of precision, accuracy and positive control will ably assist you in achieving the results you must have. We will be glad to work it out with you.



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"Gears... Good Gears Only"

Wooster Pike and Mariemont Ave. ★ Cincinnati 27, Ohio

OLDS BEARING BRONZE

For Food Equipment

BEARINGS

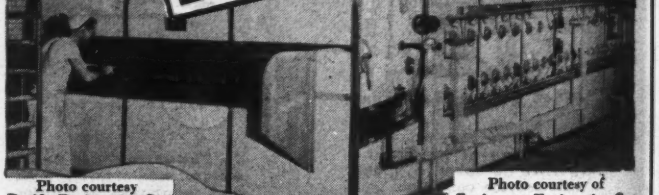
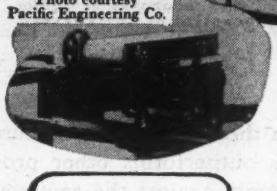


Photo courtesy Pacific Engineering Co.

Photo courtesy of Equipment Engineering Co.



From the giant continuous oven to the high speed bun slicing machine OLDS BEARING BRONZE provides trouble-free bearings to help keep food equipment in service year after year. The toughness of the alloy with its lead content provides satisfactory operation with reduced bearing friction even with little or no lubrication.

Write for Bulletin

—describing all OLDS ALLOYS and their applications to food processing equipment

OLDS ALLOYS Company

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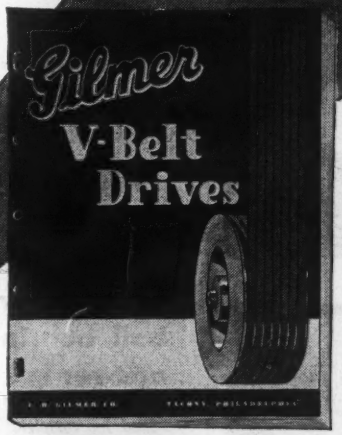
Suburb of Los Angeles

THIS FREE Gilmer Guide



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ANSWERS MANY V-BELT PROBLEMS

When you have a power transmission problem in machine design, refer to the Gilmer Guide. It contains much valuable engineering information and time-saving facts that will aid you in planning a V-Belt drive of any size or kind.

Prepared by Gilmer engineers, who have drawn from their long experience in planning drives for practically every type of industry, the Gilmer Guide is fully authoritative and is designed to meet modern needs. If you do not have a copy, write for one today.

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APPLICATIONS: typical installations of multiple V-Belt, V-to-flat Belt, and FHP V-Belt drives.

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L. H. GILMER COMPANY
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Dowel Pins

All you know to be symbolized by the ALLEN trade mark,—in metallurgy, precision workmanship, product-DEPENDABILITY, — all this applies to *TRU-GROUND* Dowel Pins *in these particulars:*

We make them of special-analysis ALLENOY steel, heat-treated to an extremely hard surface, with a core of the *right* hardness to prevent "mushrooming" when driven into a tight hole.

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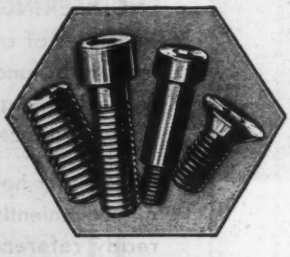

THE ALLEN MFG. COMPANY
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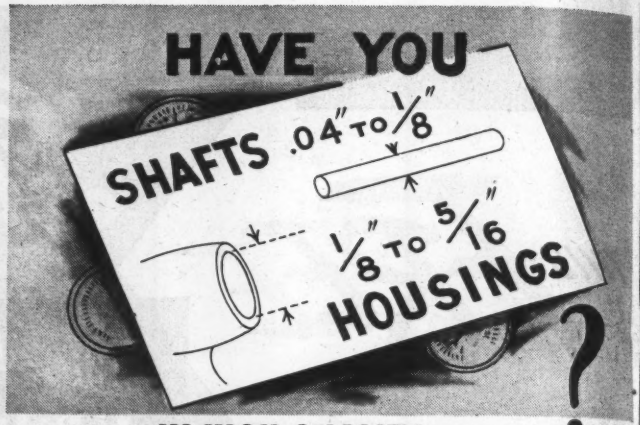

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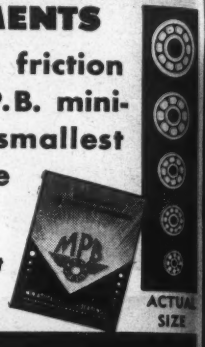
in confined spaces where friction is a vital factor? Then M.P.B. miniature bearings—world's smallest ball bearings—may be the answer!

Send for complete specifications or for competent engineering service. Write for bulletin **MD-125**



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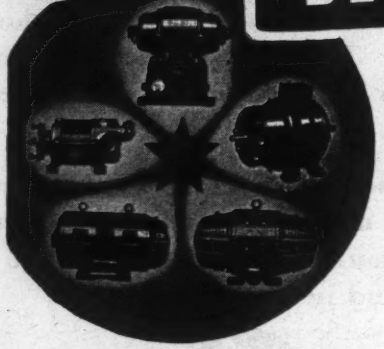

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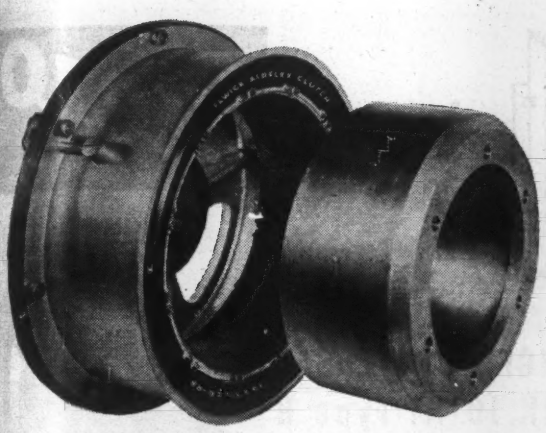
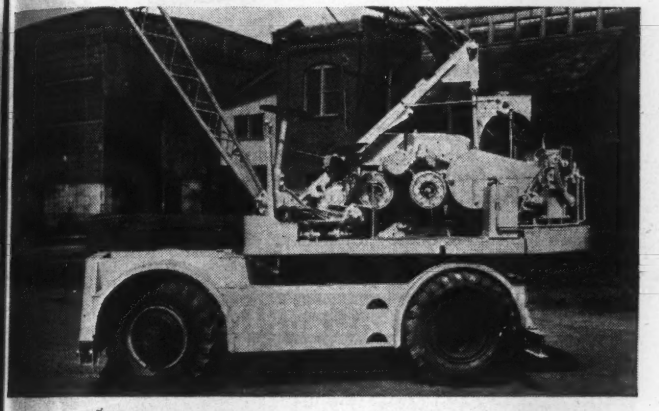
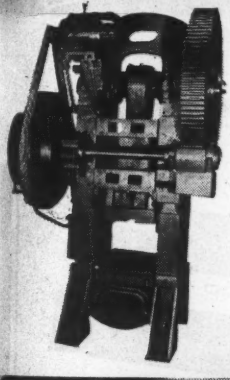


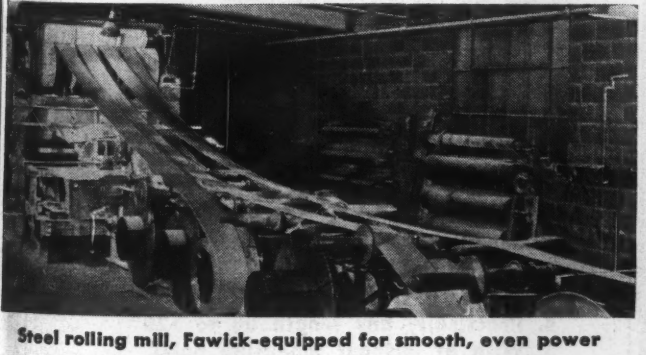
Clutch element assembly with spider



Seven Fawick Clutches are used on this new Byers ½ cu. yd. "Traveler"



250-ton press equipped with Fawick Clutch and Brake



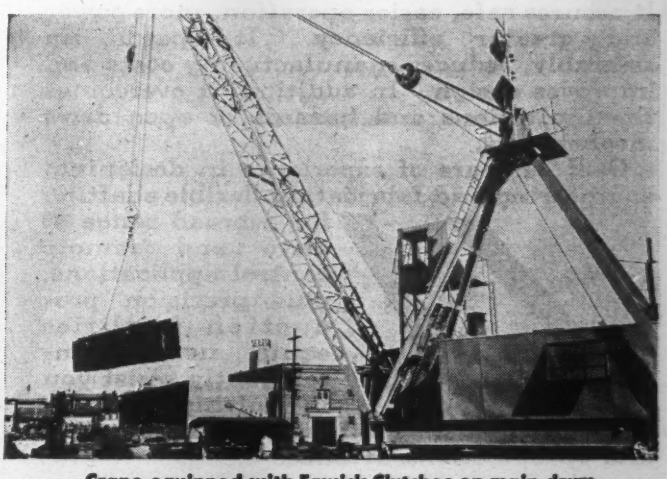
Steel rolling mill, Fawick-equipped for smooth, even power

The Fawick Airflex Clutch eliminates down time because it needs no adjustment, no lubrication, no frequent replacements and repairs. It controls torque, absorbs shocks and transmits power through a cushion of air.

Grips like a tire grips the road—light or firm engagement—without springs, arms or levers.

Economy and dependable performance proved on thousands of navy ships and in hundreds of different industrial applications—for heavy-duty drives wherever the going is tough.

Tell us the conditions your equipment has to meet in operation—We'll gladly recommend the clutch best suited to the job and show you how it should be engineered. Book on request.



Crane equipped with Fawick Clutches on main drum and swinger and Fawick Power Take-off on engine

FAWICK *Airflex* CLUTCH

FAWICK AIRFLEX CO., INC. • 9919 Clinton Road, Cleveland 11, Ohio

In Canada, Reynold-Coventry Ltd., Montreal, Toronto, Vancouver • In Britain, Crofts Engineers, Ltd., Bradford, England

SIMPLIFY COMPLEX DRIVE PROBLEMS

Mall FLEXIBLE SHAFTING
REG. U.S. PAT. OFF.

Where unconventional applications of power transmission call for carrying power around corners, bends, and other obstructions, MALL Flexible Shafting offers design engineers many production, design and performance advantages.

MALL Flexible Shafting is engineered to the job. It is dependable in every detail. It assures safe, easier operation, more power and greater efficiency. It speeds up assembly, reduces manufacturing costs and improves design. In addition, it overcomes the limitations and hazards of open drive mechanisms.

Over 24 years of experience in designing, engineering and fabricating flexible shafting for a broad range of drive and remote control applications, plus precision production facilities equip us to intelligently assist you in solving complex drive problems. Mail us your blue prints and specifications at once.

Our Engineering Staff is at your disposal. Engineering data mailed upon request.

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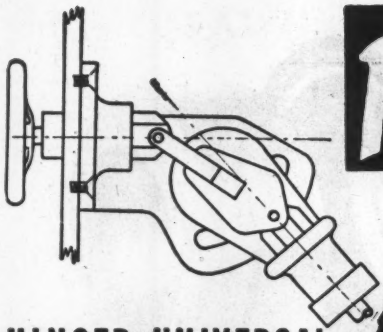
Mall PORTABLE POWER TOOLS



Piezo

IT HINGES

HINGED UNIVERSAL LINK JOINT-Type H for simplification of REMOTE CONTROLS.

This Piezo universal link joint, new in principle, transmits motion around corners and permits operation of shafts at angles from 0° to 90°. Easily installed with solid shafting, backlash is negligible. The input and output shafts turn in exact angular rotation. It is recommended for hand or low R. P. M. power operation in air conditioning equipment, aviation, railroad and marine equipment, petroleum and chemical industries, electronics, machine tools and other machinery. Write for folder 45A giving complete data and specifications.

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3. Standard Widths—¾"—1"—1½"
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6. Special shapes for unusual applications

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VULCAN ELECTRIC COMPANY
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Makers of a wide variety of Heating Elements for assembly into Manufacturer's own products and of Heating Specialties that use electricity.

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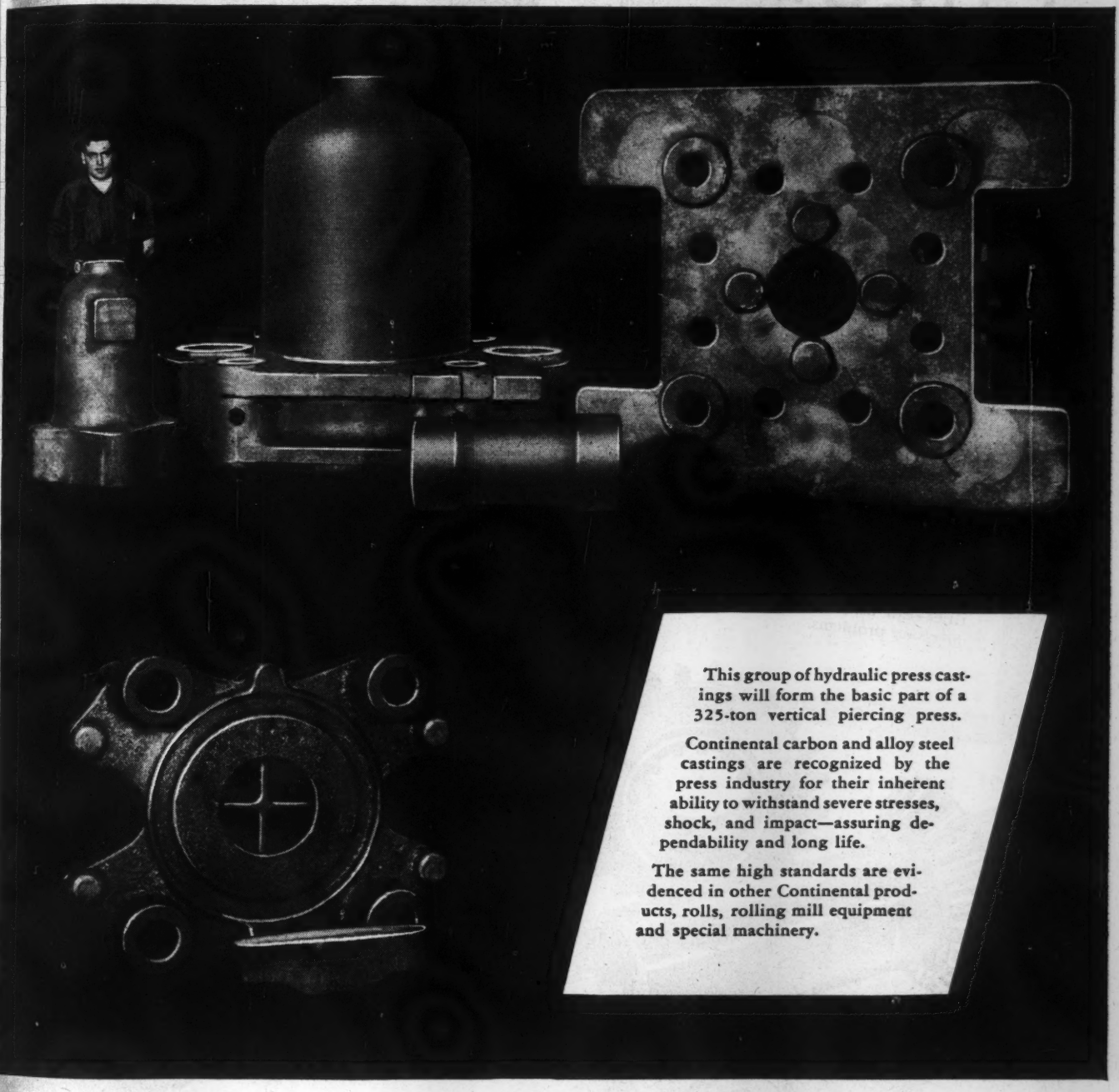


This group of hydraulic press castings will form the basic part of a 325-ton vertical piercing press.

Continental carbon and alloy steel castings are recognized by the press industry for their inherent ability to withstand severe stresses, shock, and impact—assuring dependability and long life.

The same high standards are evidenced in other Continental products, rolls, rolling mill equipment and special machinery.

CONTINENTAL *FOUNDRY & MACHINE COMPANY*

CHICAGO • PITTSBURGH

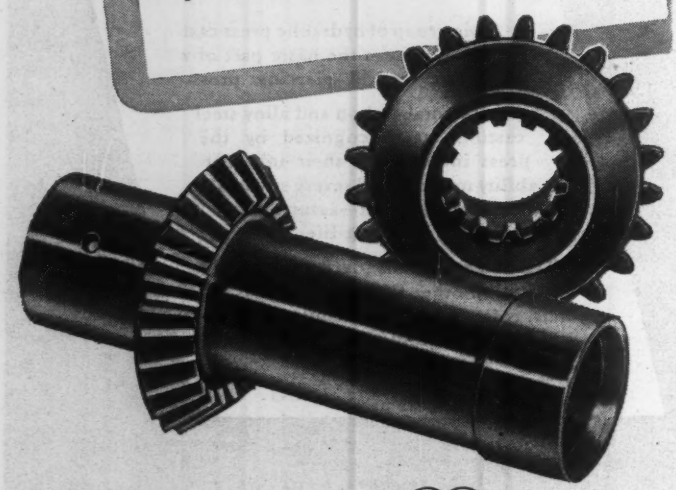
SOLVING PRECISION PROBLEMS

The first time we made this complex aircraft bevel gear, containing highly special internal splines, we did it over the week-end . . . from blue prints.

Its British prototype, the only one in this country, had failed. We received the blue prints by airmail on Thursday morning. We blanked eight parts and made temporary tooling that day, cut and splined on Friday, carburized, annealed and finish machined on Saturday, hardened and finished ground on Sunday, air expressed *eight* parts on Monday.

Admittedly, that was an extreme emergency case. But as a result of our 42 specialized years in precision gear manufacture, the versatility of our shop and craftsmen, we can produce experimental parts—from blue prints—without delay. And, we can manufacture, to the most exacting specifications, in production quantities, gears and other intricate and precise parts where the highest degree of precision performance is required.

If your new product calls for *precision* parts—in experimental or production quantities—call us. We are *specialists* in solving *precision* problems.



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INDIANA GEAR WORKS • INDIANAPOLIS 7, IND.

In The Bendix-Weiss Rolling Ball Universal Joint

Here Shown Disassembled

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Here, in the Bendix-Weiss Constant Velocity Universal Joint, Strom Balls do their part in making military vehicles, from Jeeps to 14-ton Armored Cars, the efficient fighting equipment that they are. This is only one spot in our great war production effort where the high degree of perfection of Strom Balls serves industry, enabling it to provide the finest bearing equipment towards its great contribution to total victory. Strom Steel Ball Company, 1850 South 54th Avenue, Cicero 50, Ill.

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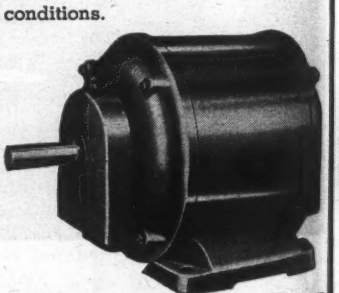
Strom BALLS Serve Industry

Design Engineers Specify

VALLEY Ball Bearing MOTORS

Because—

- They offer more flexibility in power planning.
- They are built to meet unusual power loads and high temperatures.
- They meet all operating conditions where hazards of liquids, chips, etc., dropping into the motor are involved; as well as splash conditions.
- Being made in ½ to 75 h. p. sizes, they offer wide adaptability.



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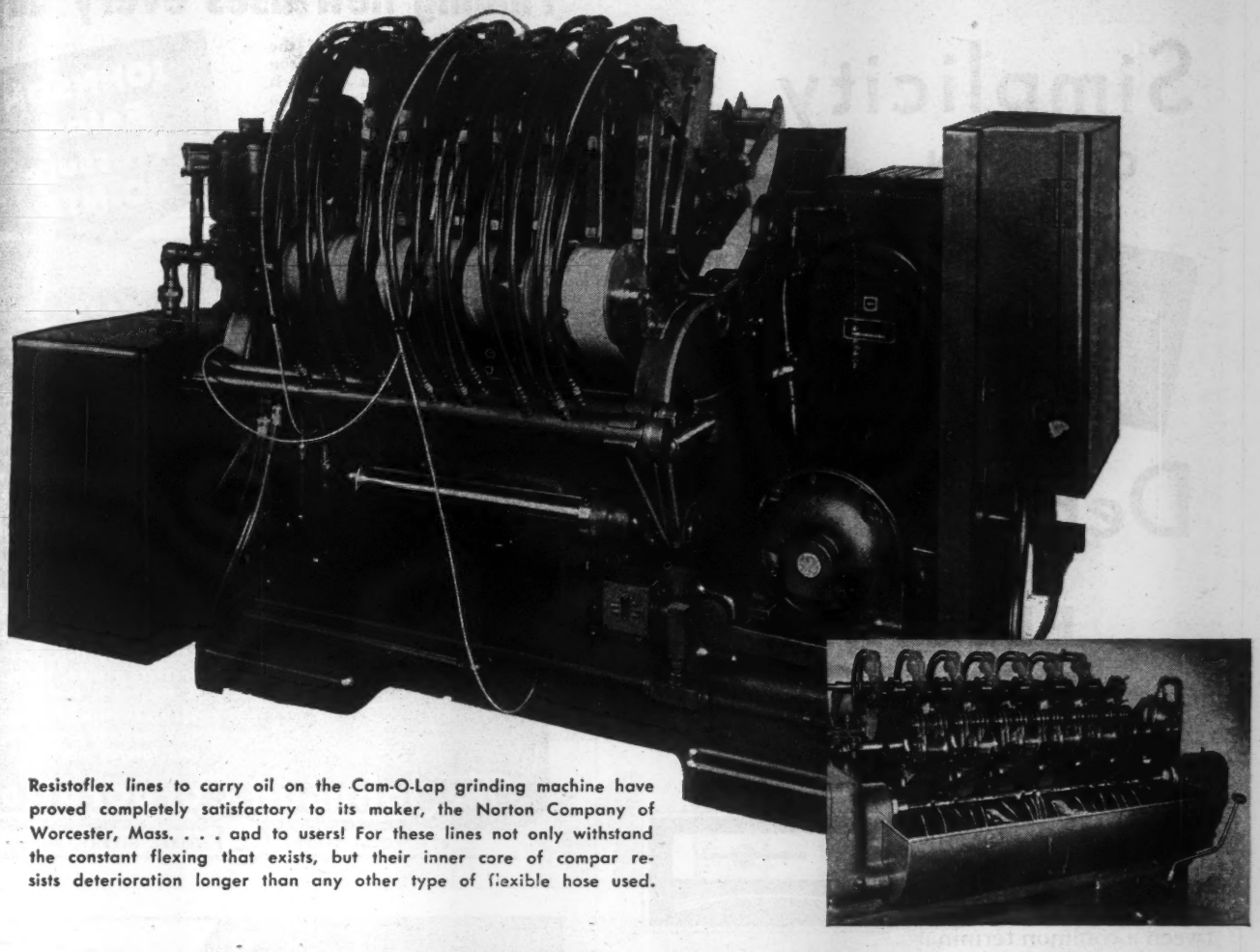
THE TUBE IS THE HEART OF THE HOSE—INSIST UPON ITS BEING MADE OF COMPAR



Resistoflex lines to carry oil on the Cam-O-Lap grinding machine have proved completely satisfactory to its maker, the Norton Company of Worcester, Mass. . . . and to users! For these lines not only withstand the constant flexing that exists, but their inner core of compar resists deterioration longer than any other type of flexible hose used.

RESISTOFLEX LINES CARRY INSOLUBLE CUTTING OILS UNDER HEAT, PRESSURE AND VIBRATION —KEEP REPLACEMENTS AT A MINIMUM!

The best Lubricant and Hydraulic Lines are Resistoflex, too

Wherever vibration is encountered—where resistance to hydraulic fluids or lubricating oils and greases is essential—designers are specifying Resistoflex. Resistoflex hose is completely immune to the action of all hydraulic fluids, completely inert to lubricants. A dependable flow is assured because the tube never rots, swells or shrinks in inner diameter. Write for details.

ARMY E NAVY

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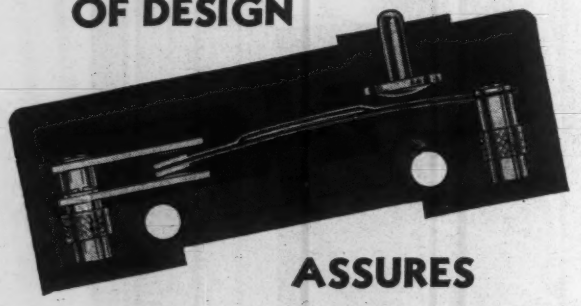
Resistoflex Corporation TRADE RESISTOFLEX MARK **Belleville 9, New Jersey**

Simplicity

OF DESIGN



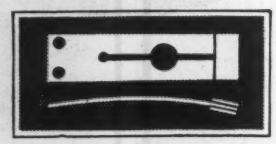
ASSURES

Dependability

in

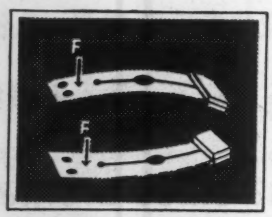
ELECTRIC CONTROL

The One-piece Spring



pre-stressed to the exact degree requisite for the desired operating characteristics . . . completes a high-current circuit between a common terminal and either of two, solid-silver, stationary contacts.

Positive Click Action



when low force is applied to the critical stressing area of the spring . . . snaps the movable contact rapidly across center, giving dependable make and break of electric circuits.

The Elementary Principle

utilized in diversified forms . . . suits Mu-Switch to varied control and indicating circuits. Write today for your copy of the new Mu-Manual giving detailed performance and application data.

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For sure
CLICK ACTION
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Please send my copy of the new Mu-Manual.

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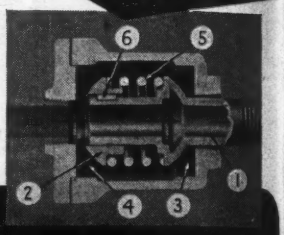
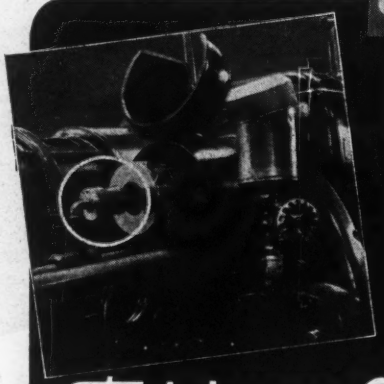
JOHNSON Rotary Pressure JOINTS

● Shown below is one of the latest applications of the Johnson Joint — on a turret lathe. It admits coolant or cutting oil into the hollow spindle—makes it possible to provide coolant directly behind cutting tools when machining inside surfaces of internally bored castings.

Industry is constantly finding new uses for this packless stuffing box—in paper and textile mills, steel rolling mills, synthetic rubber plants—wherever steam or liquids must be admitted to rotating machine parts. We will be pleased to help you investigate its possibilities for your problems.

Write for Information





PACKLESS. Pressure fills housing through sliding fit between nipple (1) and collar (2), keyed together (6) - forces seal ring (3) tightly against nipple.

SELF-OILING. Carbon graphite seal and bearing rings (4) need no oiling.

SELF-ADJUSTING. Joint is pressure sealed; spring (5) is for initial seating.

SELF-ALIGNING. Unique design permits both angular and lateral movement.

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Drawing Materials Surveying Instruments

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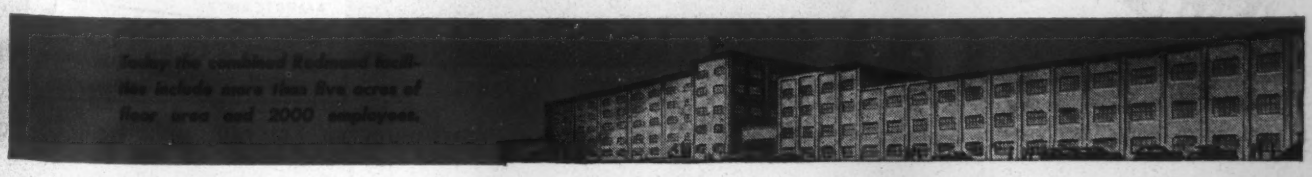
MORE THAN 15,000,000 MICROMOTORS

In twenty years the Redmond Company has become an outstanding leader in the manufacturing of small fractional horsepower motors.

Redmond **COMPANY, Inc., OWOSSO, MICHIGAN, U. S. A.**

A. C. Micromotors in sizes up to 1/25th horsepower, D. C. Micromotors up to 1/20th horsepower, Speed Controllers, and Blowers.



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If lack of proper bronze parts threatens you with costly delays, don't waste time experimenting—*call on N-B-M.*

Maybe you need a single giant rough casting—or 100,000 tiny parts, precision machined—we're ready to fill your most exacting requirements accurately and *quickly.*

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AMERICAN Brake Shoe COMPANY

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HELPFUL LITERATURE

FOR DESIGN EXECUTIVES

1. Centralized Lubrication

Farval Corp.—4-page illustrated bulletin No. 76 "When You Reconvert" presents brief summary of operation and advantages of Farval System of centralized lubrication for machines. Case studies present typical results of use of system. Complete range of systems including manual and automatic types is covered.

2. Couplings

Gleason Works—12-page illustrated bulletin No. SD 3019 "Gleason Curvic Couplings" discusses design, application and advantages of this type coupling. Design makes self-centering positive, and with teeth cut and ground on gear cutting machines, accuracy, tooth spacing and surface finish are same as obtained on bevel gears.

3. Contour Forming Machine

Cyril Bath Co.—6-page illustrated folder "Machines For Making the Shapes in Things to Come" presents details of Bath Universal stretch and compression forming machine. Specifications, typical applications and fourteen points to consider in selection of equipment of this type are outlined.

4. Rolled & Welded Products

Cleveland Welding Co.—8-page illustrated bulletin "Cleve-Weld circular rolled and welded steel products" covers facilities for producing gear ring blanks, flame cut gears, motor and generator frames, special shaped bands, special items, tractor and truck rims and other products. Services and facilities available are presented.

5. Phenolic Plastics

Durez Plastics & Chemicals, Inc.—8-page illustrated brochure "Plastics Primer" presents facts about phenolic plastics. Characteristics, uses, advantages and typical applications are shown. Table covers principal characteristics of Durez phenolic molding compounds.

6. Blind Rivets

Huck Mfg. Co.—16-page illustrated bulletin No. 451 describes operation, advantages, installation and inspection procedures with Huck blind rivets. Fastener is composed of brazier or countersunk A17ST aluminum alloy sleeved head and 14SRT aluminum alloy pin which is pressed into sleeve by pull type riveting gun.

7. Power Transmission Data

Dodge Mfg. Corp.—20-page illustrated bulletin No. A-242 is supplement to catalog No. 42 and lists important changes in line of power transmission equipment. New equipment section contains complete data on Dodge-Timken type E pillow blocks and Dodge Rolling Grip friction clutch.

8. Wood Bearings

Paramount Oilless Bearing Co.—4-page illustrated folder deals with Pobco oilless wood bearings. Data on physical characteristics, features, standard and special types and installation, operating and selection instructions are included. Typical industries served by these bearings are listed.

9. Synthetic Rubber

E. I. du Pont de Nemours & Co., Rubber Chemicals Div.—4-page illustrated "Neoprene Notebook" No. 34 marks resumption of publication of quarterly circular suspended during war. It presents engineering information and laboratory data to aid in solving new design problems.

10. Small Precision Parts

Litchfield Precision Products—4-page illustrated bulletin and enclosed list of machines present facilities for producing small precision parts for machine manufacturers. Numerous typical examples of production, including some parts within 0.00025-inch tolerance, are shown.

11. Plastics

Watertown Mfg. Co.—44-page illustrated booklet "The Watertown Book of Plastics" presents information on Neillite molding powder and compounds; thermosetting, thermoplastic and other materials; and molding, buffing, finishing, assembly and engineering technique. Stock and custom molds are shown and plastics' properties chart is included.

12. Metal Meshes

Penn Metal Co.—8-page illustrated bulletin No. 475-M contains approximate sizes, dimensions and weights of standard and flattened steel mesh. Typical applications are shown.

13. Oilless Bearing Material

Keystone Carbon Co.—4-page illustrated bulletin describes D-10 oilless bearing material, a powder metal product. Operating temperatures, tensile strength, electrical characteristics and examples of applications are covered. Other powder metallurgy parts for postwar designs are also discussed.

14. Resistors

Ward Leonard Electric Co.—32-page illustrated catalog describes various types of resistors, gives sizes and resistance values and covers mountings and enclosures. Selection and ordering data are included.

15. Vibration Pickup

MB Mfg. Co., Vibration Div.—4-page illustrated folder "MB Vibration Pickup" discusses type 124 vibration pickup for precise and detailed study of all modes of vibration in rotating and reciprocating machines and attached accessories. General description, specifications and typical calibration curve are presented.

16. Shock Mountings

L. N. Barry Co.—16-page illustrated booklet "Compression Type Shock Mountings" explains design principles and application to shipborne, mobile and portable equipment of shock absorbers in which rubber is loaded in compression. Detailed drawings, load ratings and dimensions of various types are included.

17. Conveyor Lubricators

J. N. Fauver Co.—4-page illustrated catalog No. CL345 is descriptive of automatic conveyor lubricators which provide positive lubrication for every trolley wheel bearing and every chain link pin, every trip. Frequent, measured lubrication without wastage is accomplished.

18. Couplings

Buffalo Machinery Co.—8-page illustrated bulletin No. 1007 presents information on machine tool type, transmission type and special torque control couplings. Methods of installation and use, advantages and specifications are given.

19. Flash Welding

American Welding & Mfg. Co.—4-page illustrated bulletin "Flash Welding—A Solution to Assembly of Forged Parts" outlines advantages of flash welding as saver of machine time, stock, weight and handling. Methods by which welded assemblies reduce production costs are described.

20. Pump

Marco Co.—2-page illustrated leaflet describes Flow-Master positive displacement, high vacuum pump for transferring, metering or proportioning any product that can be pumped. Structural details and specifications are covered.

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21. Mercury Clutch

Mercury Clutch Corp. — 4-page illustrated bulletin describes design and advantages of clutch using mercury to provide positive torque control in machines of all sizes. Saving of power, smooth acceleration and impossibility of stalling power source are some of advantages.

22. Silicone Rubber

Dow Corning Corp.—Illustrated folder presents data on Silastic silicone rubber which is resilient at temperatures up to 500 F and flexible at temperatures down to minus 70 F. Properties, methods of fabricating and uses are outlined.

23. Automatic Valves

A. W. Cash Valve Mfg. Co.—28-page illustrated catalog pictures, describes and gives prices of by-pass valves, industrial valves, pressure controls for hot water heating systems, pressure reducing and regulating valves, pressure relief valves, steam, water, air, oil, gas, and liquid strainers, and refrigeration valves. Piping systems are shown.

24. Clutches

Carlyle Johnson Machine Co.—16-page illustrated installation and data book No. 45 contains design principles and important features on Maxitorq floating disc clutches. Line drawings and specification tables on various models are included.

25. Color in Industry

Glidden Co.—8-page illustrated bulletin, form No. F309 "Sight Perfection" discusses colors for industrial use. Full-color illustrations show recommended methods of improving vision, increasing safety, efficiency and production with color. Color charts and codes are included.

26. Blowers

Lau Blower Co.—4-page illustrated bulletin No. 71 contains dimensional, application and performance data on 100 and 200 series blowers which range from 7½ x 7½-inch wheel to 30 x 28-inch wheel models. Blower assemblies, blower wheels and housings are described.

27. Rotary Solenoids

George H. Leland, Development Engineering —8-page illustrated booklet form No. 101-9-45 presents data on design, applications and advantages of Ledex rotary solenoids. Application to bomb release is discussed in detail and adaptability to industrial design is outlined. Engineering service is offered to designers of equipment.

28. Hydraulic Presses

Hydraulic Press Mfg. Co.—84-page illustrated bulletin No. 4500 traces history, development and uses of all types of hydraulic presses for industrial requirements. Line includes presses from small laboratory models to huge production types, and for handling metallic materials and nonmetallic materials. Hydraulic power units are described. Applications of each type are covered.

29. Air Compressors

Ingersoll-Rand Co.—24-page illustrated publication entitled "A Little Air Power Will Do Many a Big Job" contains nearly 70 photographs showing how to utilize familiar air operated equipment in new ways and to increase production through use of compressed air. Condensed data are given on type 30 air-cooled compressor, and on compressors and blowers which range up to 8000 horsepower in size.

30. Electrical Equipment

Sperti Inc.—4-page illustrated bulletin "Important Sperti Products for the Electrical and Electronic Fields" describes briefly hermetic seals, glass to metal seals that protect equipment from moisture, dust, chemical fumes and fungus growth; electron tubes made to order for special requirements; and vacuum switches for operation at high voltages, high altitudes and under high-speed keying conditions.

31. Die Castings

New Products Corp.—4-page illustrated bulletin No. 161 discusses selection of aluminum, zinc, magnesium and brass high pressure die castings for specific jobs. Selection factors, characteristics and properties of various types are covered. Typical die castings are shown.

32. Wear Resisting Material

Norton Co.—4-page illustrated bulletin "Norbide—The Hardest Material Made by Man" lists physical facts about this boron carbide material which will aid in its application. Uses include wearproof gages, blast cleaning nozzles which will outlast steel nozzles thousands of times, metallurgical compounds requiring economical source of boron and as extremely hard abrasive for lapping operations. Other uses are suggested by tables of characteristics.

33. Hydraulic Oils

Warren Refining & Chemical Co.—72-page illustrated catalog entitled "Warren Specialized Lubricants" explains development and application of hydraulic power, selection and functions of hydraulic oils, and characteristics and properties of various hydraulic fluids.

34. Gear Inspection

Vinco Corp.—12-page illustrated bulletin No. 91 describes gear rolling inspection fixtures and master gears which provide means for accurately checking backlash and runout of all types of gears. Details are given on various types of units.

35. Vinyl Resin

Resistoflex Corp.—16-page illustrated catalog lists industrial parts made from compar specially compounded solventproof vinyl resin. Data are given on lubricant and grease hose hydraulic hose, chemical hose, refrigerant hose transparent tubing, end fittings, industrial gloves work aprons, mechanical molded goods, coatings, adhesives and paints.

36. Flexible Couplings

Union Chain & Mfg. Co.—16-page illustrated bulletin No. FC-1 presents information about chain and flexible couplings. Types are shown and applications of each are covered. Tables of service factors, dimensions and list prices are included.

37. Counting & Timing Devices

Production Instrument Co.—8-page illustrated bulletin No. 50 is entitled "Modern Counting Timing & Recording Devices." Data are included on stroke and revolution counters, electric counters, counter actuating switches, time totalizer, Clipper high speed coil winding counters and predetermined electric counters. Application information is included.

38. Spacer Tubes

National Formetal Co.—1-page bulletin discusses nine features of "Superformed" spacer tubes available to exact length required. Specifications are given.

39. Die Castings

Parker White Metal & Machine Co.—32-page illustrated catalog "Parker—Erie" explains advantages of die castings and their use in design of machines and equipment. Design and production facilities of company are discussed. Typical die cast parts in aluminum, zinc, brass and alloys are described. Case studies and design factors are included.

40. V-Belt Drives

American Pulley Co.—Illustrated catalog of "American Fractional-Horsepower Wedgbelt Drives" gives list prices and specifications on new line of sheaves and belts. Condensed and simplified drive tables for wide range of center distances and drive ratios are included.

41. Electric Heating Units

Watlow Electric Mfg. Co.—26-page series of bulletins in wirebound file type folder provides specifications and other data on cartridge, strip, wide strip, immersion, tubular and ring type electric heaters and temperature controls. Industrial hot plates are also covered. Installation and care of these units are discussed. Electric heating tables and engineering data complete book.

42. Colloidal Graphite

Acheson Colloids Corp.—12-page illustrated bulletin No. 430-XX describes physical and chemical properties of "dag" colloidal graphite. Reasons for using liquid carriers and how dispersions are controlled accurately are discussed. Use of colloidal graphite as running-in lubricant for high temperatures, for impregnating porous bodies and for electrical applications are covered.

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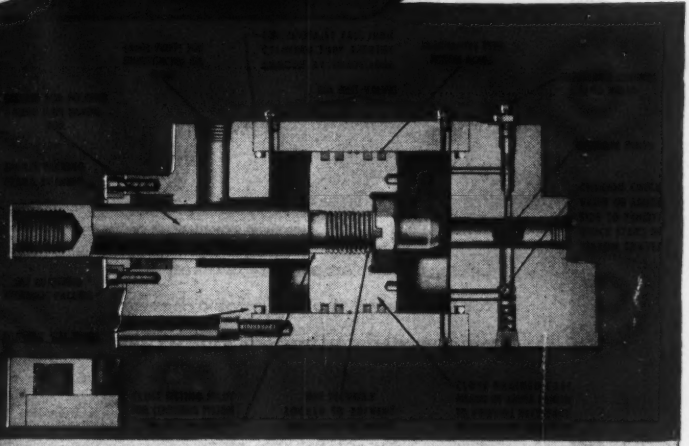

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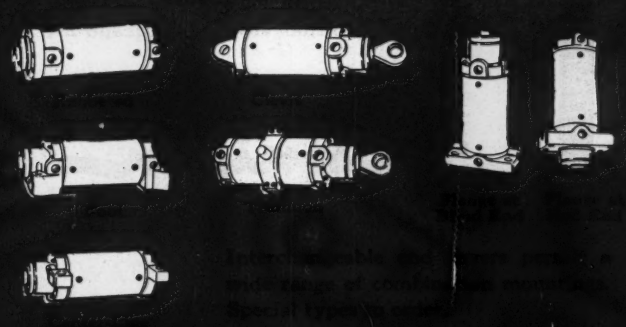
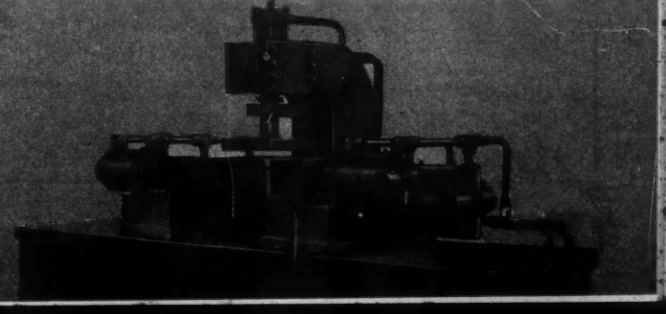


(*Below*) Hydraulic piercing press with four standard Logan ROTOCAST Hydraulic Cylinders mounted horizontally to the right and left of the work to perform the piercing operation.



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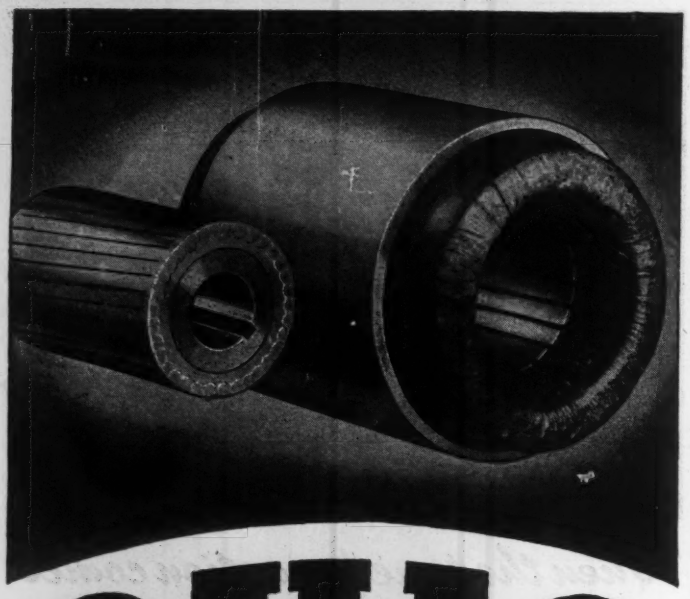

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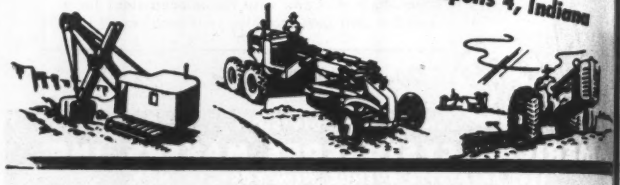

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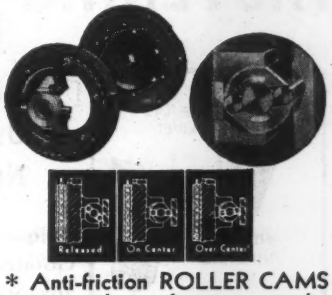

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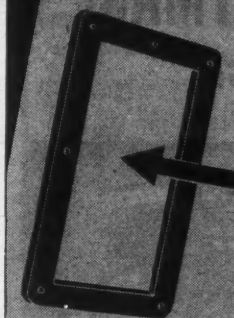

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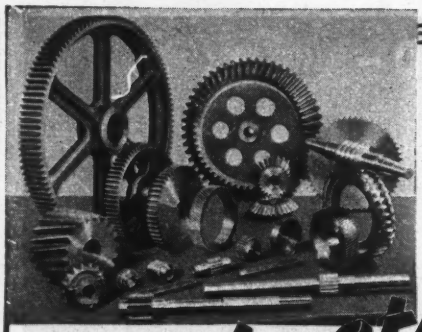

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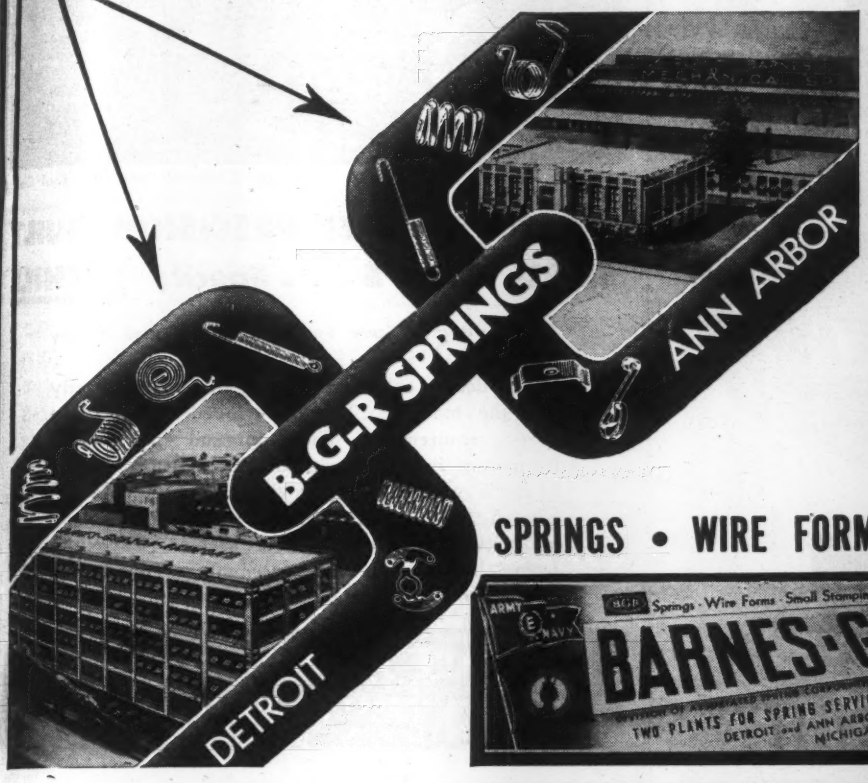

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These Illustrations Show the Patented Construction of a Janette Wheel. The blades are formed in pairs for rigidity. The blade slots in the steel discs are die cut to ensure exact spacing of the blades. The hub is riveted to the back plate; then the blades are inserted into the slots. After the blades are spot welded to the back plate the tips are pressed thru the slots of the inlet disc, then rolled down against the disc.

The Inherent Spring of the Blades Keeps Them Tight.

Because of This Construction, Janette Wheels have given over 19 years of universal satisfaction to internationally known manufacturers of coal stokers, blowers, ventilating equipment, air cooled engines, oil burners, superchargers, dust collectors, drying and fire detection apparatus. **It Will Pay You to Give Janette Blower Wheels a Trial!**

May We Send Literature?

Janette Manufacturing Company
556 W Monroe St Chicago 6, Ill

with Ruthman

GUSHER

COOLANT PUMPS

With the return to normal competitive conditions, the accent will be on increased production at lowered costs.

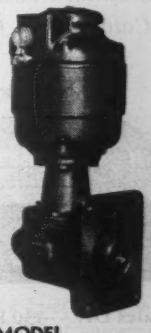
Here Ruthman Gusher Pumps are years ahead of their time. By actual test, they have proved their superiority time after time by giving efficient economical service with minimum maintenance costs.

So look ahead with Ruthman Gusher pumps. You can be sure that Ruthman is alert to improvements and refinements to give you the best product.

There's A "Gusher" for Every Requirement

Write now for our new catalog.

THE RUTHMAN MACHINERY CO.
1811 READING ROAD
CINCINNATI 2, OHIO
The "GUSHER"—A Modern Pump For Modern Machine Tools



MODEL 11020-A

TOUGH *and* TOPS in "PUSHABILITY"

For a "tough" trucking job you want a "tough" caster, one that will stand the gaff and be easy on the "push." For years, the Rapids-Standard Company has been specializing in making casters of this type. Rapids-Standard casters are "steel-forged" for strength and longevity while the exclusive "Rapid-Flame-Hardening" process of treating swivel raceways gives a Brinell hardness of 500-550 — almost twice that of "ordinary" casters. This hardness feature is indispensible today, when your equipment is subjected to heavy overloading.

Don't be satisfied with anything but the best—get the complete facts on Rapids-Standard casters. Write for Catalog No. 65-2C.

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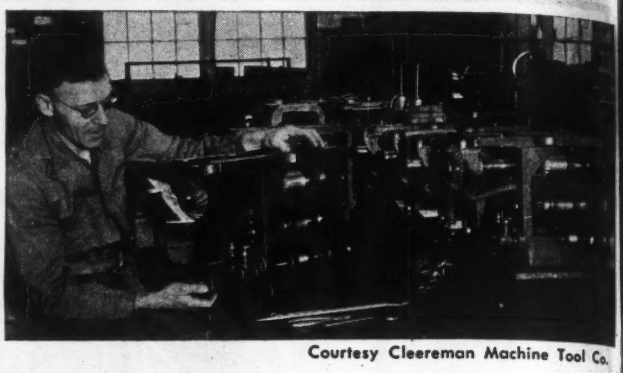
Manufacturers of
STEEL FORGED CASTERS - TRUCKS - CONVEYORS - POWER BOOSTERS

The Rapids-Standard Co., Inc.

Sales Div.—330 Peoples Nat'l Bank Bldg., Grand Rapids 2, Mich.



Courtesy Cleereman Machine Tool Co.

WHEN YOU NEED PRECISION-BUILT SMALL PUMPS . . . *Specify* TUTHILL

Built-in Pumps Save Space, Material and Money

When design calls for building the pump directly into the machine, Tuthill Stripped Pumps meet every requirement. These internal gear rotary pumps are furnished without mounting bracket, as Model S; or with pumping elements only, as Model SA. Available for pressure lubrication, coolant, hydraulic and liquid transfer service. Capacities from 1 to 50 g.p.m. Also automatic reversing type. Write for Tuthill Stripped Pump bulletin.

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This exclusive direct drive coupling, with rubberized cushion gripped permanently by die-cast ends, has no parts to get out of order, or to lubricate. Minimizes misalignment, free end float, and backlash. Custom-made for specific job. Lengths from 2-1/2" up. Bores 5/16", 3/8", 7/16" and 1/2". A million giving satisfactory service.

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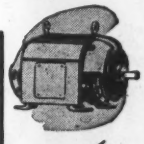
OF SUPERIOR SILVER BRUSHES
AGAINST YOUR NEEDS



CHARACTERISTICS OF SUPERIOR SILVER GRAPHITE BRUSHES

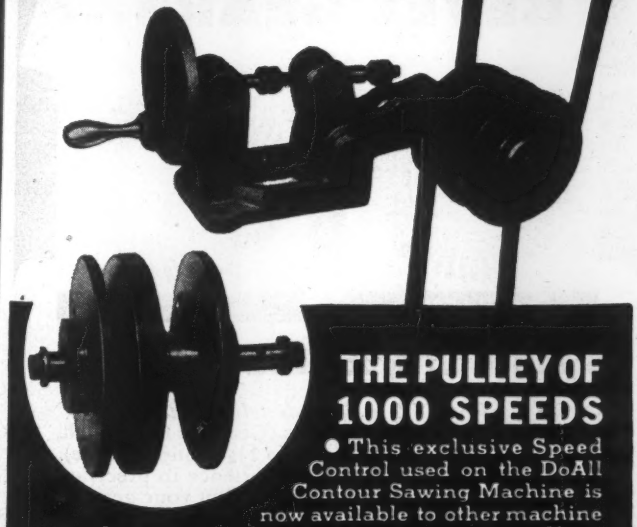
Grade No.	Percentage of Silver	Specific Resistance per Inch Cube	Hardness	
B-54	20%	.00045	25-30	Artificial graphite base
C-45	50%	.00015	20-25	Artificial graphite base
D-10	50%	.0001	20-25	Graphitized base stock
D-11	20%	.0004	20-25	Graphitized base stock
E-65	10%	.0008	25-30	Artificial graphite base
E-72	60%	.00003	15-20	Artificial graphite base
E-60	15%	.00065	15-20	Natural graphite base
E-82	15%	.001	65-70	Lamp black graphite base

If you don't see exactly what you want here, our Research Department will be glad to work out the one right answer for you.

SUPERIOR CARBON PRODUCTS CO.
9117 GEORGE AVENUE CLEVELAND 5, OHIO

Since 1919 SUPERIOR CARBON BRUSHES

SPEEDMASTER



THE PULLEY OF 1000 SPEEDS

● This exclusive Speed Control used on the DoAll Contour Sawing Machine is now available to other machine manufacturers who are looking for the finest Variable Speed Control . . . Changes speeds instantly—no adjustments or work stoppages. Free floating pulley provides automatic alignment of belts insuring long belt life. Three sizes, 6½", 4½" and 3½" . . . Our Engineering Department is available for consultation.

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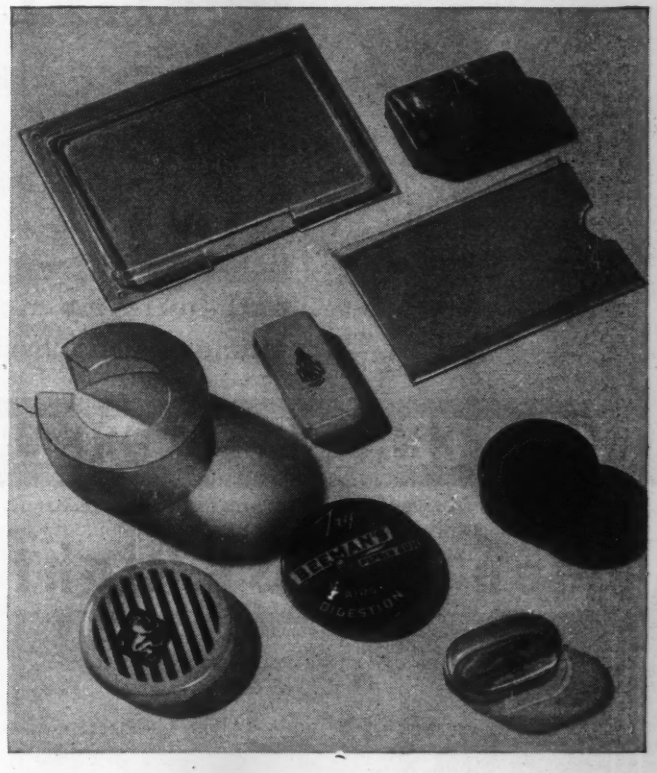
PRECISION-MADE TO YOUR EXACT SPECIFICATIONS



Here is a dependable source for quality special parts or products fabricated from plastic sheets, tubes and rods. No matter how complicated your requirements may be, you can count on Sillcocks-Miller specialists to deliver accurate work to meet your most exacting specifications. You'll find it costs you less to pay a little more for Sillcocks-Miller quality.

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Peerless QUALITY MOTORS

SINGLE PHASE • POLYPHASE • DIRECT CURRENT

Fifty-one years in the production of quality electrical equipment have given Peerless engineers and craftsmen proficiency and experience in designing and building motors of maximum efficiency and trouble-free operation.

THE PEERLESS ELECTRIC CO., WARREN, OHIO

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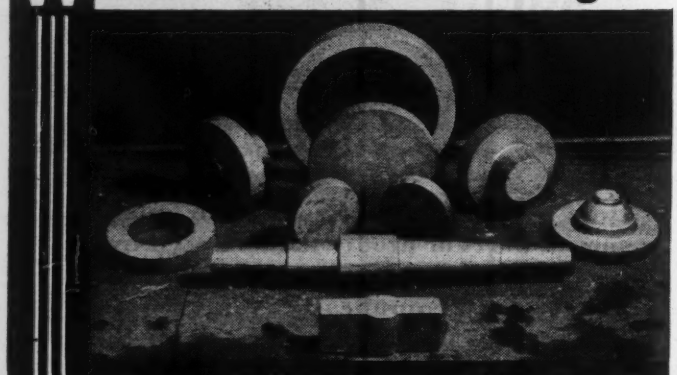

is WRONG!

Precision in a flat die forging is one of the most difficult tasks for the forger—yet many jobs have demanded forgings that are within very close tolerances . . . and we have delivered! Less machining, fewer man hours required on the finished piece results from our forging accuracy. Remember us, our forgings are economical to buy and to process.

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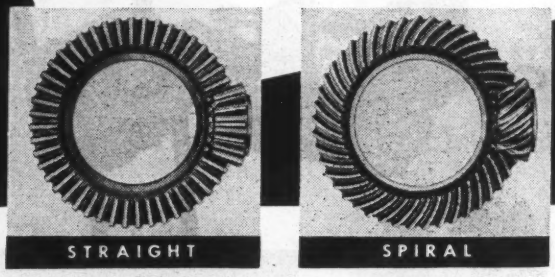

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OPEN CAPACITY is *immediately available* on 3" Straight Bevel Gear Generators (Gears 72 to 10 pitch, ¼" to 4 7/16" pitch diameter, ¼" to 2¼" cone distance). Experts with eighteen years' experience in precision cutting and testing bevel gears will cut your gears to extremely fine tolerances for pitch line concentricity and tooth spacing to insure proper tooth bearing and smooth rolling action. Send us your blueprints and specifications for our quotation.

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Adhesive Coated E-Z-FRISKET

A PREPARED FRISKET PAPER always ready for instant use!

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E-Z Frisket comes to you prepared with the *adhesive already* on the back. You simply peel off the protective backing and it's ready for use.

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E-Z Frisket is extremely strong, cuts easily, makes sharp hair-lines and doesn't curl at the edges. When you are finished you simply peel the film from the copy. There's no cement or residue to remove and copy remains in perfect condition.

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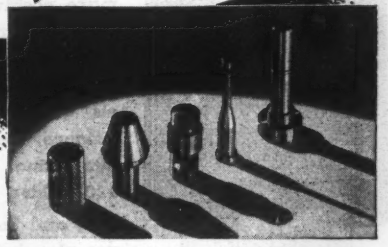
On Your Screw Machine Requirements



This screw-machining plant can become an important department of your factory—through quick service of your requirements for such parts—precision-machined to perfection for immediate trouble-free assembly. Secondary operations such as heat treating, grinding, drilling—almost any processing operations you specify are obtainable here. Send your blue prints for quick quotation.

AMON-SCHULTE CO.

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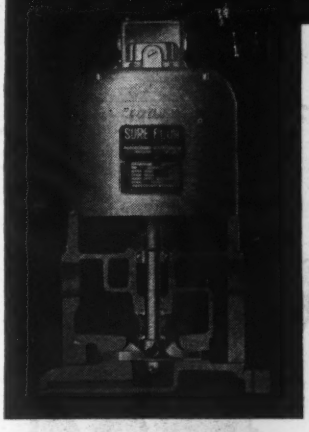
Get Higher Pumping Efficiency with...

the NEW, improved Logan SURE-FLOW coolant pumps



✓ New High Efficiency Long Life Impeller

✓ Motor Sealed Against Splashing and Grit

✓ Self-Priming without Submerging Types*

✓ New Grinder, Submerged and High Speed Pumps

✓ 27 Standard Models to Fit Your Requirements

For coolant pumping efficiency that keeps pace with today's fast-cutting, high precision machines . . . for peak performance in your future developments . . . specify the new, *improved* Logan SURE-FLOW Centrifugal Pumps.

This outstanding coolant pump has been re-engineered from top to bottom to embody exclusive new features and Logan engineering developments. By applying these advantages to your work, you will help your modern machines and cutting tools to operate at maximum capacity.

The open, unloading type impeller of improved design discharges air or vapor rapidly. There are no close tolerances or metal-to-metal contacts of running parts . . . liquids containing some abrasives, filings or other foreign matter can be handled safely. The integral motor drive permits the SURE-FLOW pump to be mounted anywhere. No gears, chains or other mechanical drive are required.

Foot and bracket mounted models are *self-priming without submerging* . . . can be located above or below the liquid level, or remote from the supply. The Logan line also includes new *grinder* and *submerged* type pumps, as well as *high-speed* models for driving stream, deep hole drilling and chip flushing applications.

*FOOT MOUNTED

*BRACKET MOUNTED

FLANGE MOUNTED (intake thru flange)

Available in 5 Types

Logan SURE-FLOW Coolant Pumps are now available in 5 mounting types and 27 standard models to fit a wide range of applications. Obtain these profitable advantages for your equipment . . . investigate SURE-FLOW pumps today.

GRINDER TYPE (intake thru flange)

SUBMERGED TYPE

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Air and Hydraulic Equipment
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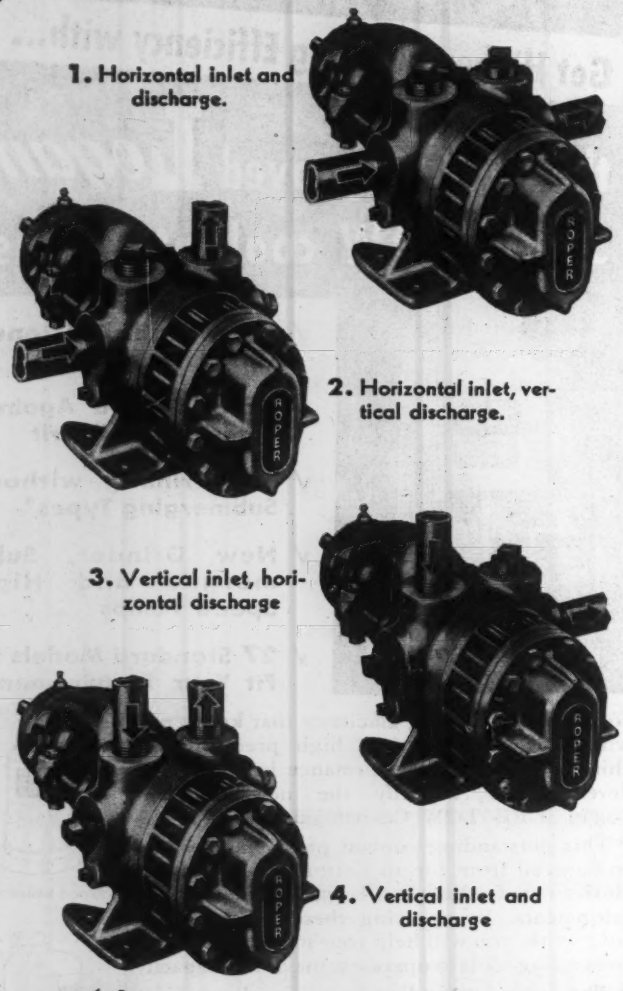
CHUCKS • CYLINDERS • VALVES • PRESSES • SURE FLOW COOLANT PUMPS

FREE Catalogs...Write for literature covering items in the Logan line in which you are interested.



4 PORT DESIGN

CUTS INSTALLATION TIME

ON ROPER PUMPS

● Before you replace your worn out or obsolete rotary pumps, it'll pay you to get full details on the Roper line today. For example, the Roper 4-port design offering 8 different piping connections will help you cut installation costs. 4 piping arrangements are illustrated with pump operating clockwise... 4 other arrangements are possible with pump operating counter clockwise.

Roper pumps run quietly and efficiently in either direction. They are designed along the correct hydraulic principle and built compactly to fit a wide range of application and mounting conditions.

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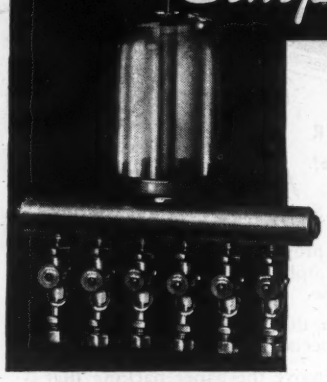
Write for Booklet "How To Solve Pumping Problems", Ask for Bulletin No. 12-32.

Service and Engineering Offices in Principal Cities

ROPER Rotary Pumps

MULTIPLE LUBRICATION *Simplified*



Here you have only one receptacle to watch and keep filled—a time saver and an assurance of dependable lubrication. Gits "MD" Sight Gravity Feed Multiple Oiler is a simple, practical and economical means of lubricating from 3 to 12 individual points from a central reservoir. Large capacity, transparent unbreakable plastic reservoir provides clear vision of oil contents at all times. A shut-off valve is located at the top of the transparent reservoir to prevent oil flow to the horizontal oil chamber when machines are not operating. Each drip fitting is equipped with an individual needle valve adjustment for regulating flow of oil, which can be locked against vibration. Ask for complete information on range of models and prices. Gits Catalog No. 60 illustrates and describes a full line of Oilers, Oil and Grease Seals and Lubricating Devices—write for your copy.

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A new series of Plugs and Sockets designed for highest electrical and mechanical efficiency. Improved Socket Contacts provide 4 individual flexing surfaces which make positive contact over practically their entire length. The Contacts on both Plugs and Sockets are mounted in recessed pockets greatly increasing leakage distance, thereby increasing voltage rating. Insulation is of BM 120 molded Bakelite.

Plug and Socket contacts are silver plated. The finished appearance of this series will add considerably to your equipment.

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The 2400 Series are interchangeable with the 400 Series. Send today for general catalog No. 14 listing and illustrating our complete line of Plugs, Sockets and Terminal Strips.

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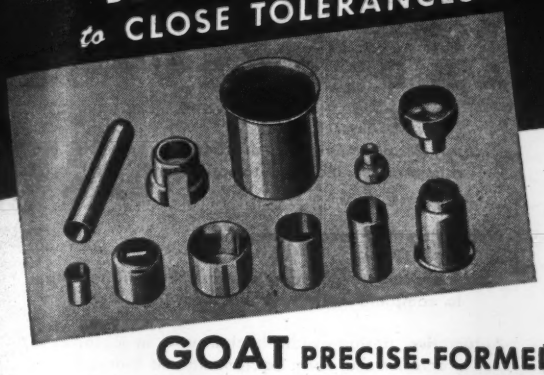

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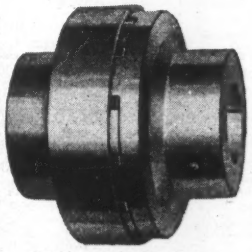
Your Coupling Needs will be most economically, and most efficiently served, with the new L-R Catalog at hand. Send for it. Pictures and describes L-R Couplings for every duty and kind of service from 1/6 to 2500 h.p. Correct for misalignment — take up shock and vibration. Extremely quiet. Non-lubricated. NO SHUT-DOWNS FOR CHANGING. Quick-Finding Selector Charts. Wire or write.



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New L-R Type "C" illustrated. Steel collar extension gives *smooth all-over surface* with accessibility. Added protection. Minimum resistance.

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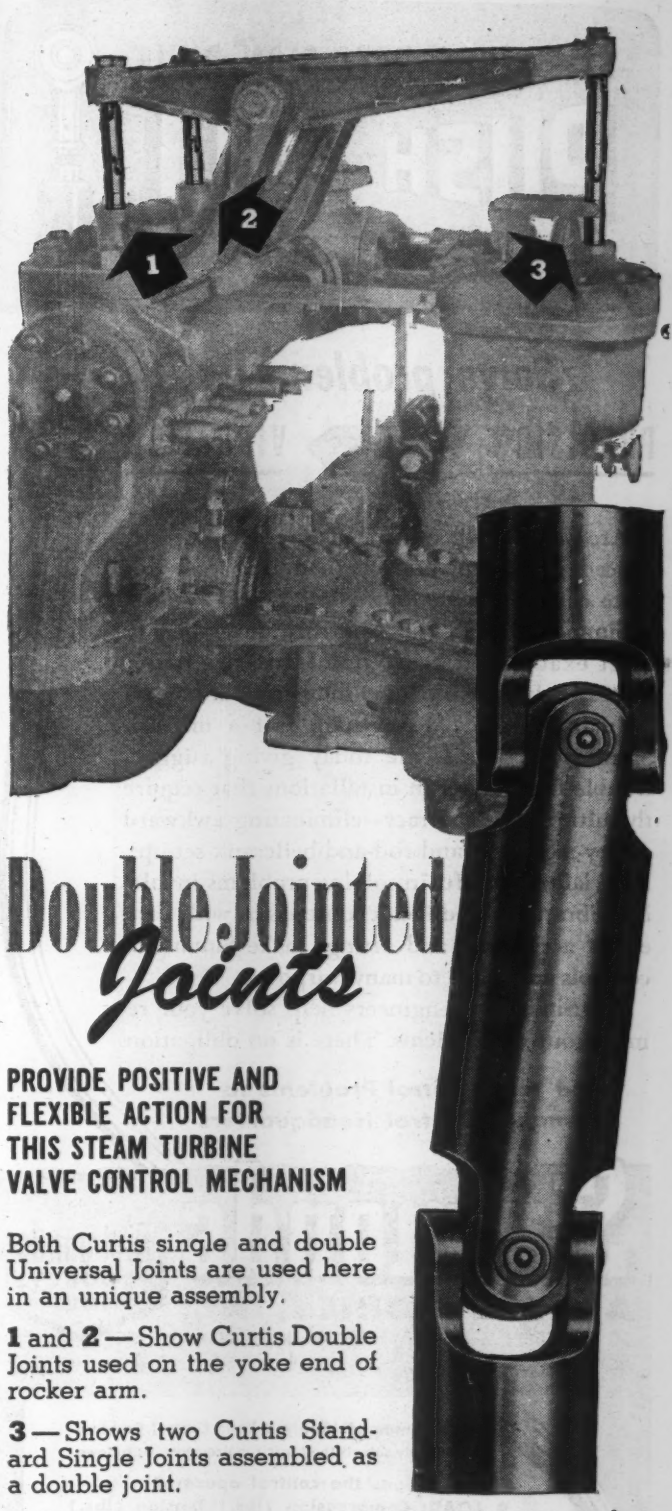

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PROVIDE POSITIVE AND FLEXIBLE ACTION FOR THIS STEAM TURBINE VALVE CONTROL MECHANISM

Both Curtis single and double Universal Joints are used here in an unique assembly.

1 and **2** — Show Curtis Double Joints used on the yoke end of rocker arm.

3 — Shows two Curtis Standard Single Joints assembled as a double joint.

This is just one of many special applications where Curtis Joints, either single or double, or in combination, have met and overcome difficult requirements.

Again Curtis "Standards" of quality and long life have been selected to give trouble-free operation with minimum maintenance.

When you encounter such difficult problems in your planning — *let Curtis Engineers work with you.*

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PUSH-PULL CONTROLS

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Let Simmonds engineers help solve your remote control problems. There is no obligation.

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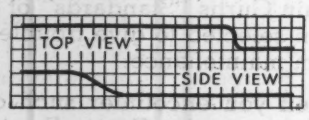
Let Simmonds Analyze Your Control Problem

Simply submit the basic requirements, as follows:

- **What does the control operate?**
- **LOAD: Compression (lbs.) Tension (lbs.)**
- **VIBRATION CHARACTERISTICS**
- **TEMPERATURE CONDITIONS**
- **PRESENT SYSTEM**
- **FLEXIBLE OR RIGID HOUSING?**

Make sketches of top and side views of installation. Use regular graph paper and indicate unit of measure.



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The Viking Pump Company is represented by a nation-wide sales and service organization in key cities from coast to coast - from Canada to the Gulf. Is your pumping installation operating at high efficiency? Do you have a pump maintenance problem? Write or call the Viking representative nearest your plant for service.

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Phone Cherry 0687

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Phone Lincoln 4788

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REDUCE MAINTENANCE COSTS

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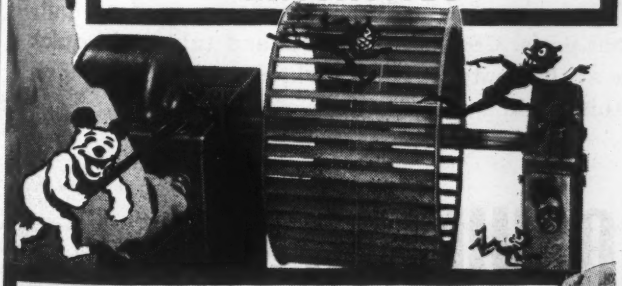

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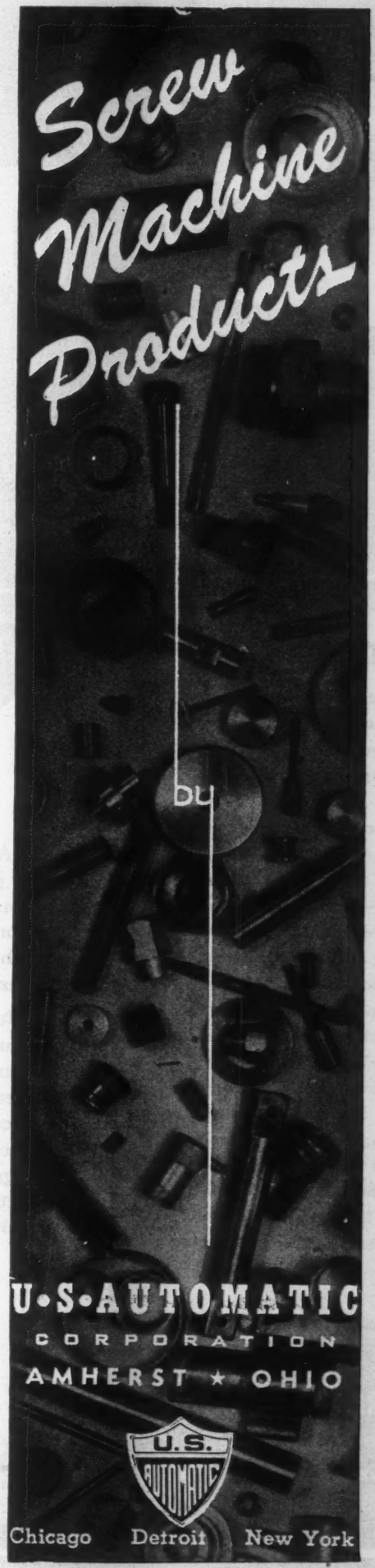

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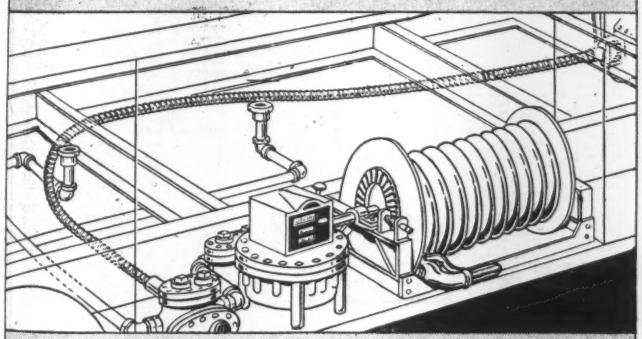

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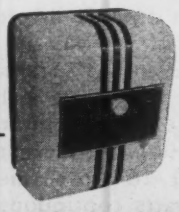
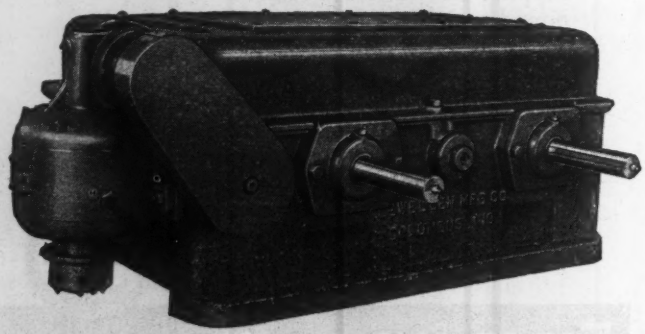


Control Station



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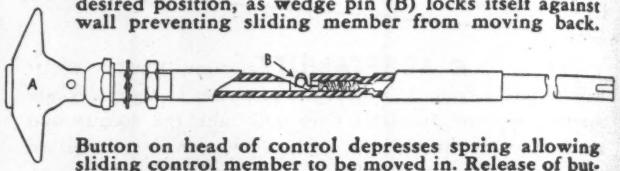

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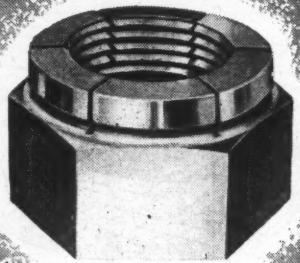

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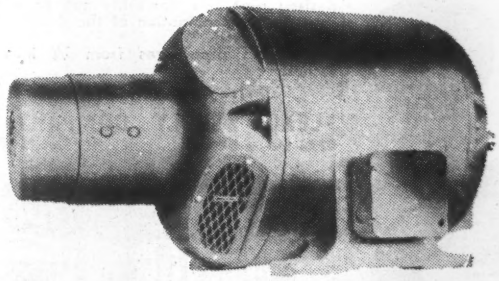

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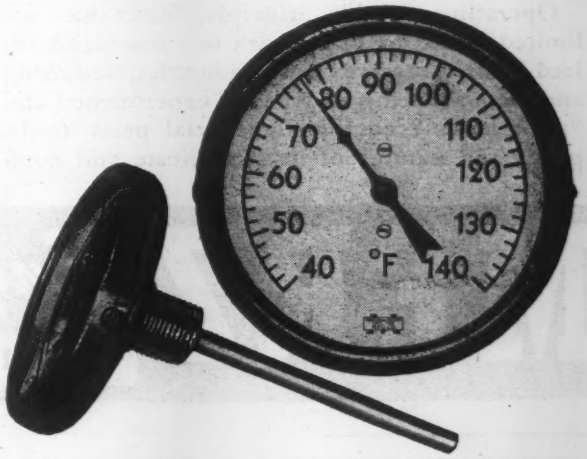

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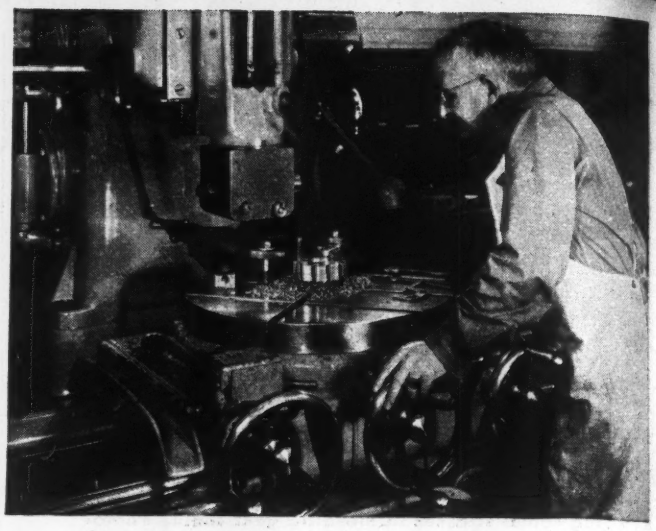

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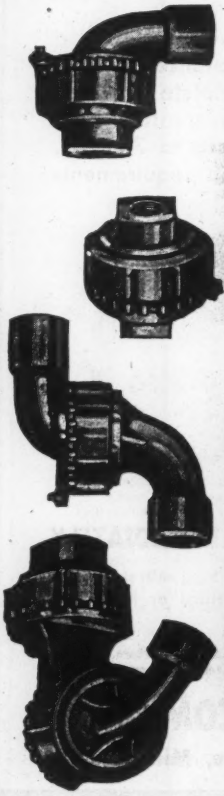

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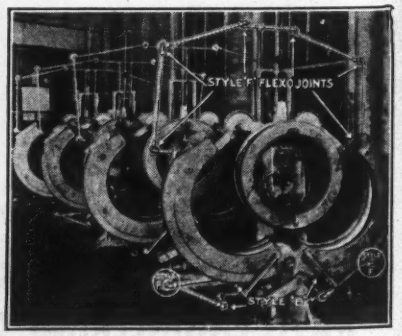

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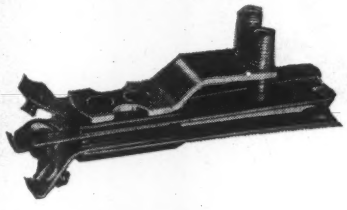

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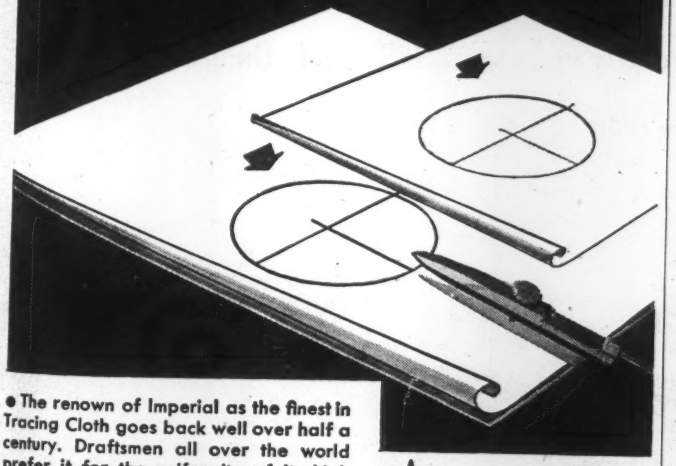

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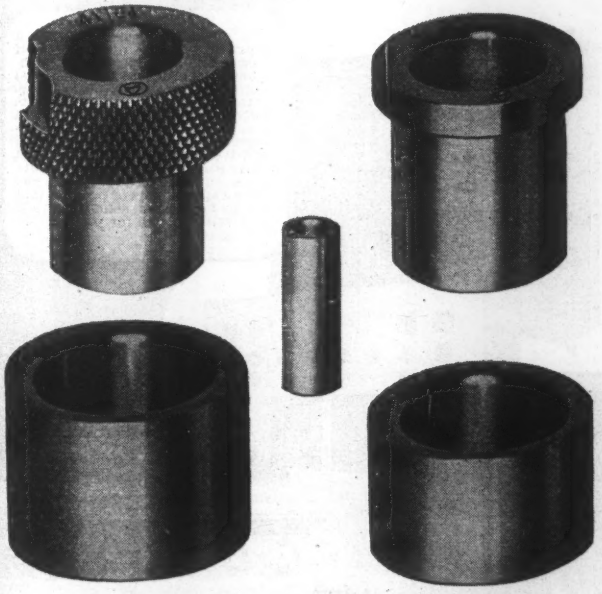

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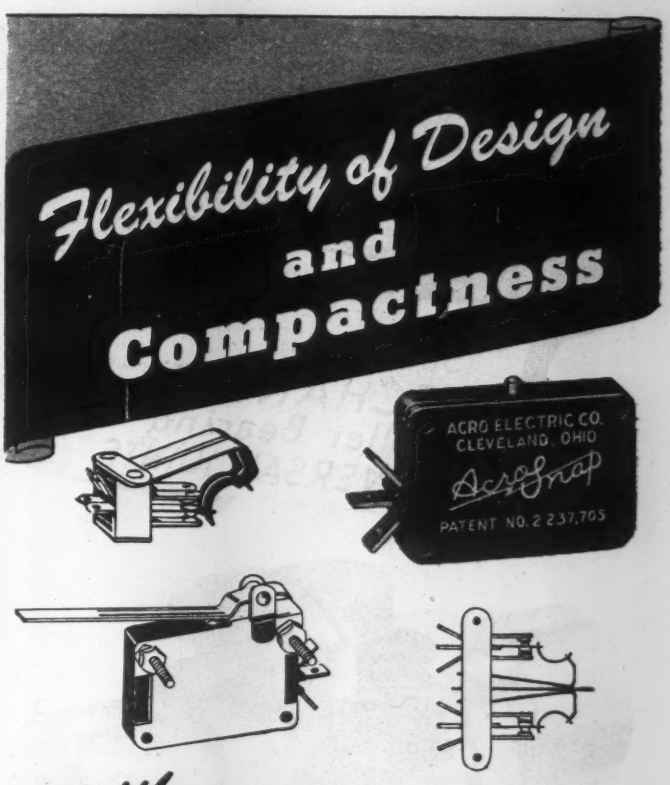

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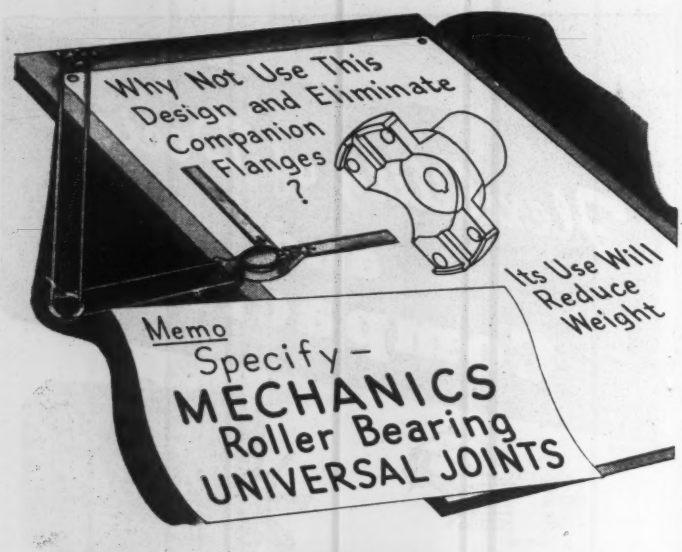

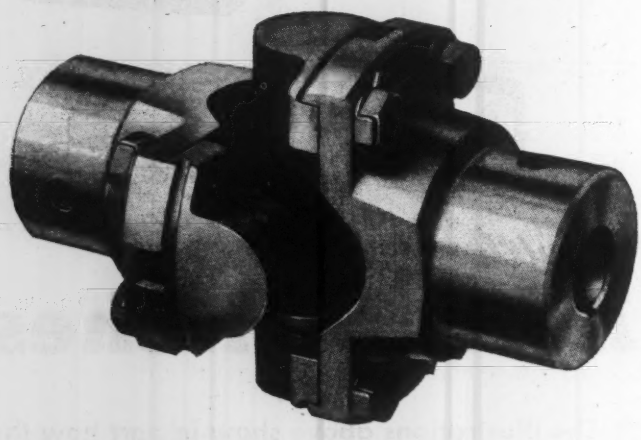

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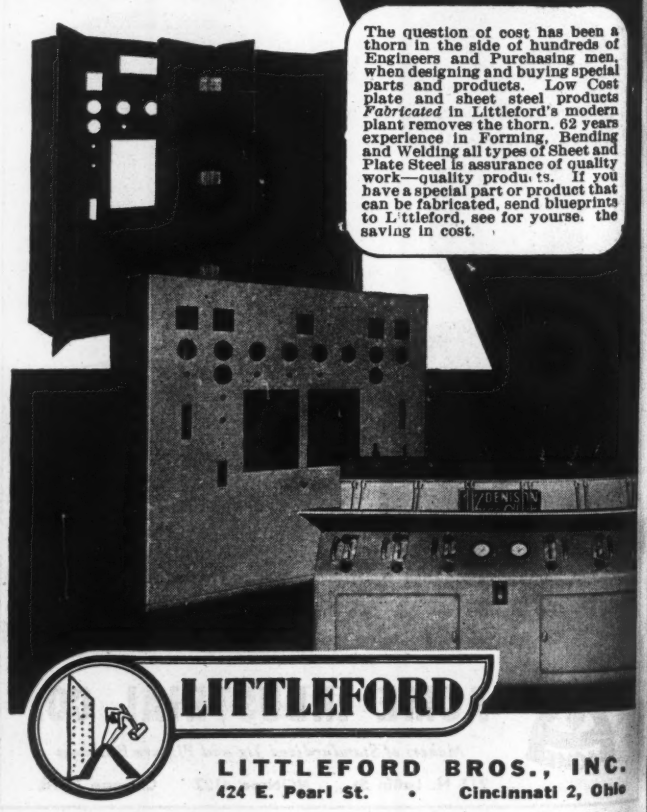

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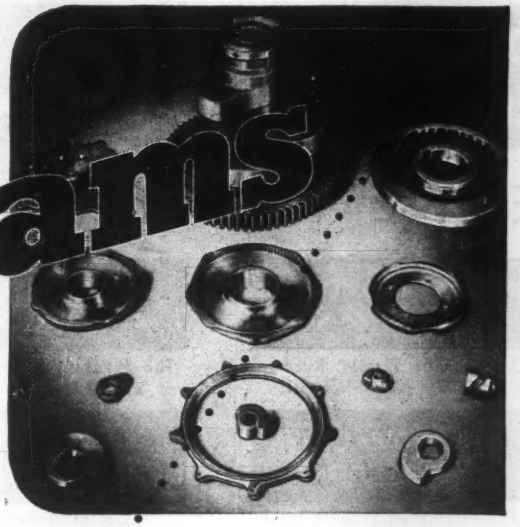

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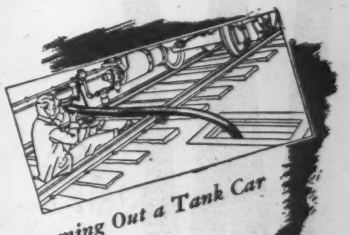
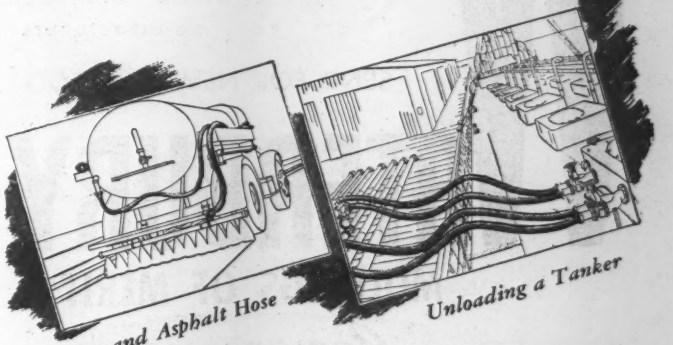


Steaming Out a Tank Car



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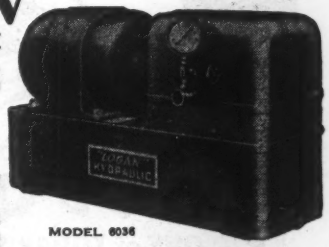

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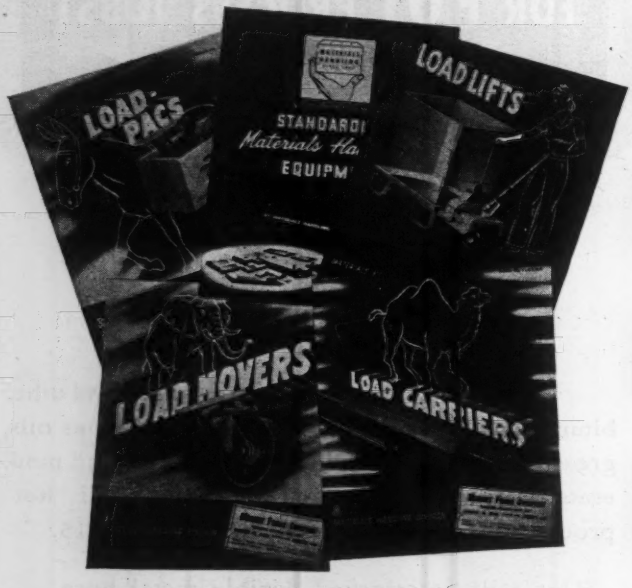

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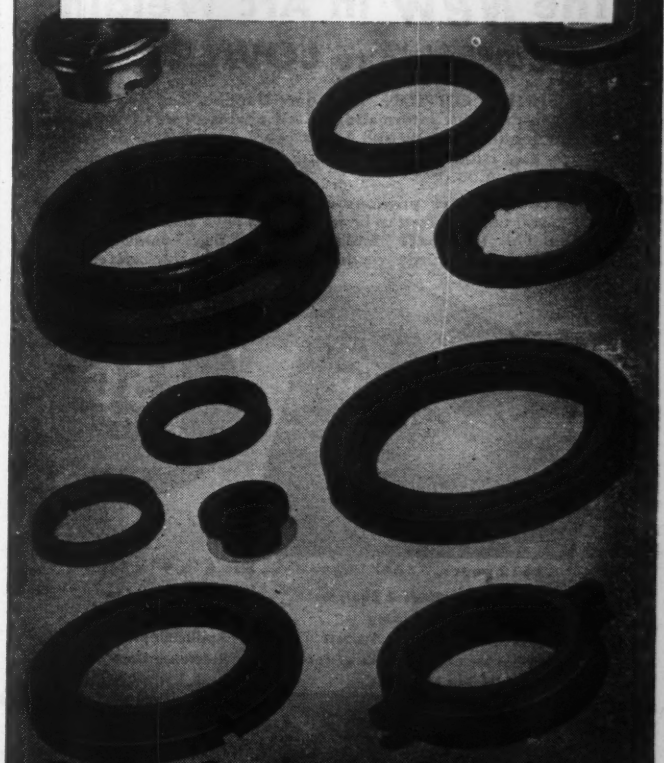

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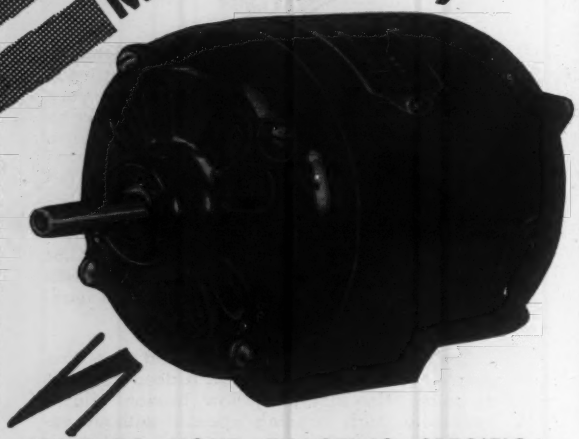

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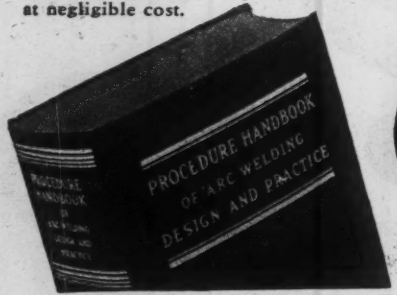

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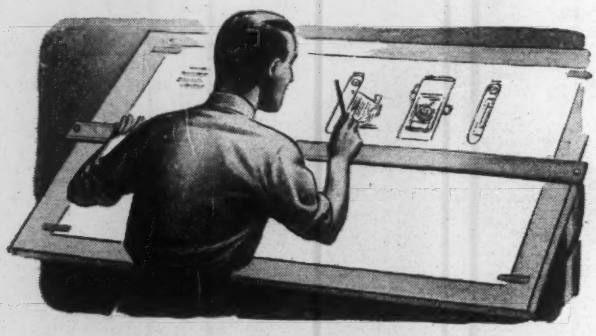
It was a slow and troublesome job to drive small slotted screws in fastening a pressed fabric panel on this electrical relay for the F-80 Jet Plane. Frequent driver skids gouged the special fungus-resistant varnish, forced disassembly and junking of marred panels.

OUTPUT HITS STRIDE

Assembly of this part was speeded up 400% when a change was made to Phillips Recessed Head Screws. Fumbling was ended, and a spiral driver could be used, permitting faster driving. Driver skids were eliminated, along with waste of parts and time for disassembly and reassembly.



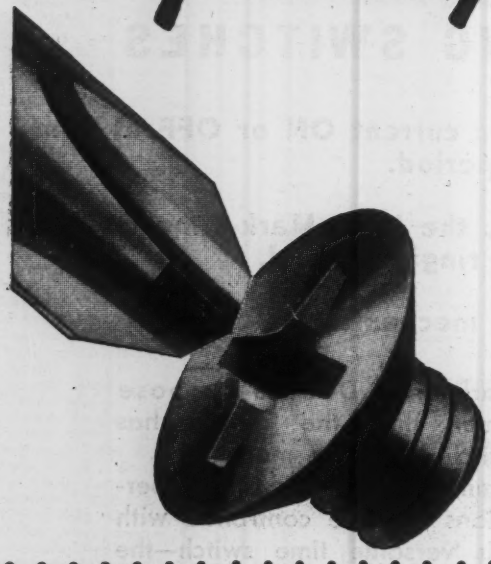
NEW STRENGTH SUPPLIED

Design engineers favor Phillips Screws, because they not only speed output and reduce costs . . . they also permit design improvements that add strength, often with the use of fewer screws. This advantage is especially evident in compact, complicated assemblies.

SHOW IT WITH PRIDE

Wherever screw heads are exposed, the Phillips Recess adds a sales advantage. No unsightly burrs to snag clothing or nick fingers – and sidetrack sales! Its ornamental design blends with modern contours – and it needs only a quarter turn to line up – looks well in any position.

It's Phillips — the engineered recess!



In the Phillips Recess, mechanical principles are so correctly applied that every angle, plane, and dimension contributes fully to screw-driving efficiency.

. . . It's the exact pitch of the angles that eliminates driver skids.

. . . It's the engineered design of the 16 planes that makes it easy to apply full turning power – without reaming.

. . . It's the "just-right" depth of recess that enables Phillips Screw Heads to take heaviest driving pressures.

With such precise engineering, is it any wonder that Phillips Screws speed driving as much as 50% – cut costs correspondingly?

To give workers a chance to do their best, give them faster, easier-driving Phillips Recessed Head Screws. Plan Phillips Screws into your product now.

PHILLIPS *Recessed Head* SCREWS

WOOD SCREWS • MACHINE SCREWS • SELF-TAPPING SCREWS • STOVE BOLTS

Made in all sizes, types and head styles

25 SOURCES

American Screw Co., Providence, R. I.
Atlantic Screw Works, Hartford, Conn.
The Bristol Co., Waterbury, Conn.
Central Screw Co., Chicago, Ill.
Chandler Products Corp., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
General Screw Mfg. Co., Chicago, Ill.
The H. M. Harper Co., Chicago, Ill.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
Manufacturers Screw Products, Chicago, Ill.
Milford Rivet and Machine Co., Milford, Conn.
The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N. H.
Parker-Kalon Corp., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Manufacturing Co., Chicago, Ill.
Reading Screw Co., Norristown, Pa.
Russell Burdsall & Ward Bolt & Nut Co., Port Chester, N.Y.
Scovill Manufacturing Co., Waterville, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
The Steel Company of Canada Ltd., Hamilton, Canada
Wolverine Bolt Co., Detroit, Mich.

MASTER GEARHEAD MOTORS

COST REDUCED by the elimination of bearings, couplings, chains, and sprockets, gear trains or separate gear reducers . . . only one unit to mount . . . lower assembly costs.

COMPACT. High reduction ratios secured in small space by using heat treated special alloy steels for both splined shafts and gears.

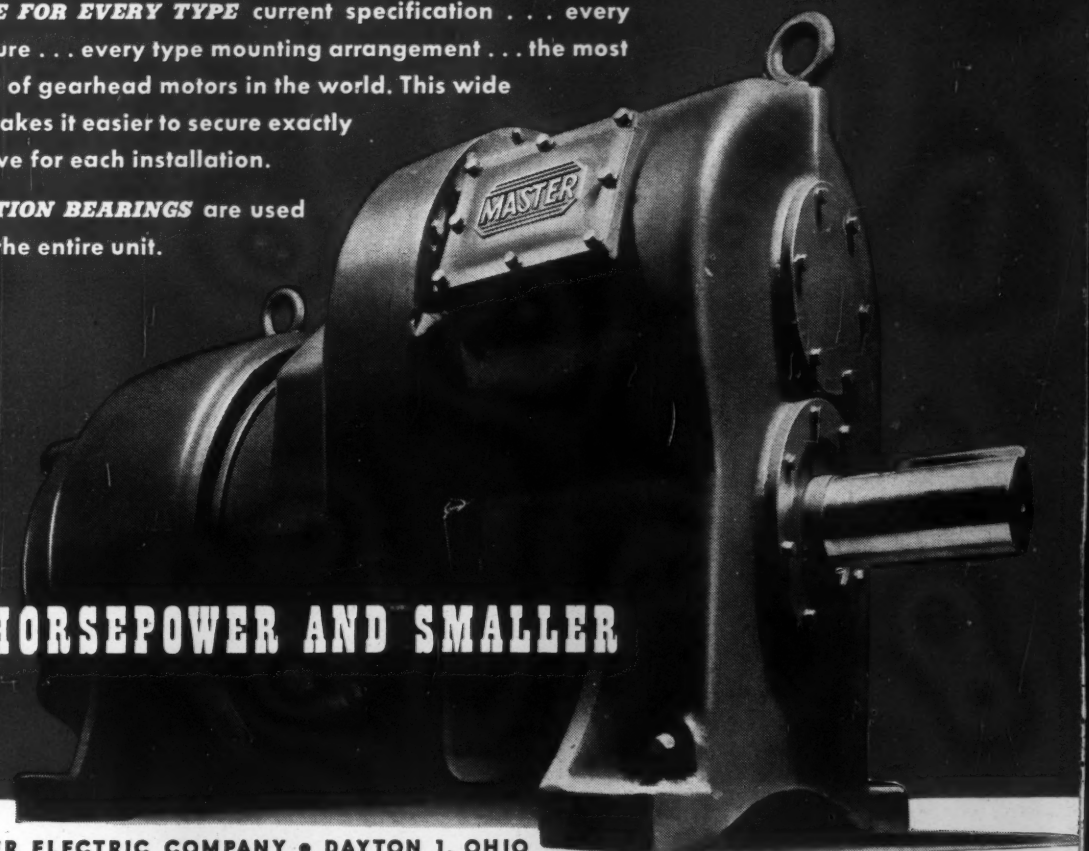
HIGHER EFFICIENCY than other types of slow speed drives . . . only 2 percent power loss in each stage of gear reduction, in parallel shaft types.

SIMPLIFIED DESIGN. More compact . . . less weight . . . permanent alignment . . . fewer moving parts . . . high efficiency . . . longer, reliable, trouble-free operation.

INTEGRAL CONSTRUCTION. Both motors and gears are designed, built, and guaranteed by one organization as a well balanced power package.

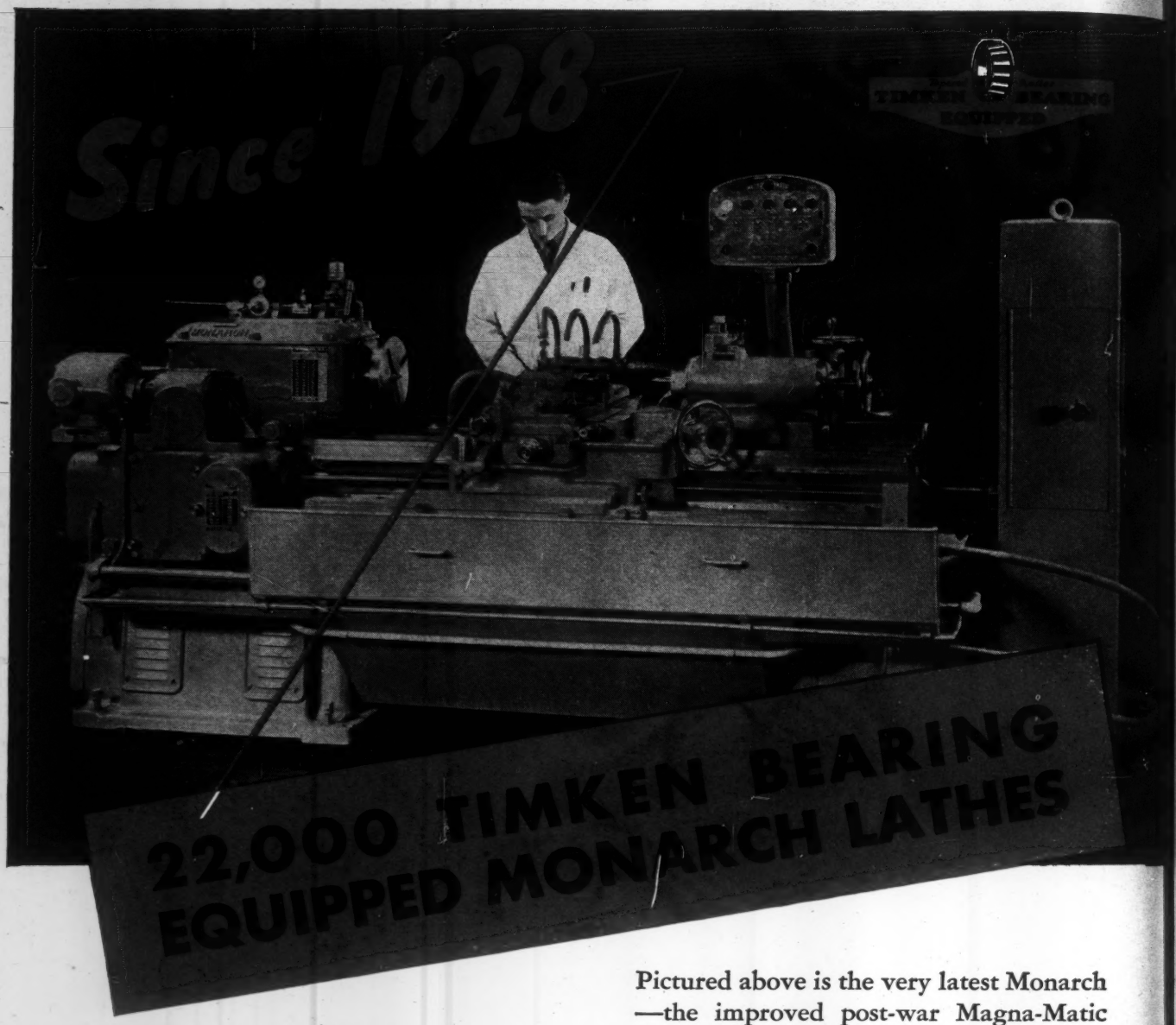
AVAILABLE FOR EVERY TYPE current specification . . . every type enclosure . . . every type mounting arrangement . . . the most flexible line of gearhead motors in the world. This wide flexibility makes it easier to secure exactly the right drive for each installation.

ANTI-FRICTION BEARINGS are used throughout the entire unit.



100 HORSEPOWER AND SMALLER

THE MASTER ELECTRIC COMPANY • DAYTON 1, OHIO



The Monarch Machine Tool Company, Sidney, Ohio was one of the first heavy-duty machine manufacturers to recognize the advantages of Timken Tapered Roller Bearings for machine tool applications.

Since adopting them in 1928, more than 22,000 Monarch Lathes—equipped with an average of 24 Timken Bearings each—have been shipped.

Pictured above is the very latest Monarch—the improved post-war Magna-Matic full automatic lathe, entirely electrically operated. Each of these machines contains 47 Timken Bearings to help create and preserve the fine precision performance, speed and economy for which the name "Monarch" has become synonymous.

Make sure you have Timken Bearings in your new equipment—and see that the trade-mark "TIMKEN" is stamped on every bearing you use. The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS